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Socio-Economic and Institutional Factors in Irrigation Return Flow Quality Control

Volume I
Methodology

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SOCIO-ECONOMIC AND INSTITUTIONAL FACTORS IN IRRIGATION RETURN FLOWQUALITY CONTROL

Volume I: Methodology

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FOREWORD

The Environmental Protection Agency was established to coordinate administration of the major Federal programs designed to protect the quality of our environment.

An important part of the Agency's effort involves the search for information about environmental problems, management techniques and new technologies through which optimum use of the nation's land and water resources can be assured and the threat pollution poses to the welfare of the American people can be minimized.

EPA's Office of Research and Development conducts this search through a nationwide network of research facilities.

As one of these facilities, the Robert S. Kerr Environmental Research Laboratory is responsible for the management of programs to: a) investigate the nature, transport, fate, and management of pollutants in ground water; b) develop and demonstrate methods for treating wastewaters with soil and other natural systems; c) develop and demonstrate pollution control technologies for irrigation return flows; d) develop and demonstrate pollution control technologies for animal production wastes; e) develop and demonstrate technologies to prevent, control, or abate pollution from the petroleum refining and petrochemical industries; and f) develop and demonstrate technologies to manage pollution resulting from combinations of industrial wastewaters or industrial/municipal wastewaters.

This report contributes to the knowledge essential if the EPA is to meet the requirements of environmental laws that it establish and enforce pollution control standards which are reasonable, cost effective and provide adequate protection for the American people.

William C. Galegar
Director
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PREFACE

This report concentrates on the presentation of a process for implementing technical and institutional solutions to the problem of return flow pollution. This process, under the general title of "Socio-Economic and Institutional Factors in Irrigation Return Flow Quality Control," was centered around a methodological and pragmatic definition of the problem and identification and assessment of a wide range of potential solutions for diverse situations. Four separate but interrelated volumes summarize the study:

volume I -- Methodology (Main Report)
volume II -- Yakima Valley Case Study
volume III -- Middle Rio Grande Valley Case Study
volume IV -- Grand Valley Case Study.

Volume I (the main report) summarizes the overall research approach of the study; the methodological premises; the nature of the problem; the process for identifying and assessing appropriate solutions; and, some general remarks and conclusions concerning the process of implementation. Volumes II to IV allow for an in-depth presentation of the approach utilized as well as specific findings and recommendations relating to the problems of each case.

The interdisciplinary team has also prepared a separate "executive summary'' which is quite a shortened version and with the help of accompanying illustrations attempts to provide in a succinct form the major findings of the study as well as the proposition involved in the identification, assessment and evaluation of potential solutions concerning irrigation return flow.

ABSTRACT

The purpose of this study has been to develop an effective process for implementing technical and institutional solutions to the problem of return flow pollution. The process developed: a) defines the problem in terms of its legal, physical, economic, and social parameters; b) identifies potential solutions in relation to the parameters of the problem; c) assesses potential solutions for diverse situations; d) specifies those solutions or groups of solutions which are the most effective in reducing pollution and are implementable.

This process is conceptualized in Volume I of the study. The general results of its application are further presented in three separate volumes concerning the specific case studies of Yakima Valley (Washington), Middle Rio Grande Valley (New Mexico and Texas), and Grand Valley (Colorado).

This report was submitted in fulfillment of Grant Number R-803572 by Colorado State University under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period between February 14, 1975 to November 14, 1977, and work was completed as of May 4, 1978.

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The authors are deeply indebted to the many farmers, state water resource agency personnel, and many in their capacity as managers and directors of irrigation districts and companies in the various states, who provided invaluable information to the team members during interviews and in supplying reports and data.

SECTION 1

INTRODUCTION

The concern with the quality of our nation's waters is not new. The "Harbor Pollution Legislation of 1888" and the "Rivers and Harbors Act of 1899" are strong evidence of a long-standing concern for water quality. From that time until the present, quite a number of legislative enactments have reaffirmed a national commitment to the control of water pollution and the enhancement of the water resources of the nation. Included among them are:

- The Oil Pollution Act of 1924;
- The Water Pollution Control Act of 1948 with amendments of 1956;
- The Federal Water Pollution Control Act of 1961;
- The Water Quality Act of 1965;
- The Clean Waters Restoration Act of 1966.

The major emphasis of past legislation has been the control of point sources of discharge from municipalities and industries, which were highly visible and much more easily controlled. It is only recently, with the Federal Water Pollution Control Act Amendments of 1972, that pollution problems associated with agricultural water use are finally addressed as part of the national legislation. This Act provides the transformation of a concern from point sources to nonpoint pollution sources, and the most difficult problem in agricultural water use, namely, irrigated agriculture.

It is obvious from the above that water quality control has become a broad national objective since the enactment of P.L. 84-600, the Water Quality Act of 1956. As emphasized, from 1956 until the late 1960's the concern has been almost entirely upon control of point sources of discharge from municipalities and industries. Obviously, these elements of pollution could be easier identified and various legal and economic measures could be designed to induce or compel elimination or reduction of harmful discharges.

Contrasted to this concern, three different conditions have produced a slow response by state and local officials with regard to agricultural pollution control programs. The first condition is the relative invisibility of nonpoint pollution. The second has to do with the more or less localized nature of the adverse effects from agricultural pollution and the difficulties of determining injuries in the absence of obvious outfalls. Finally, it is only recently that a concerted effort by the Federal Government has been undertaken in order to tackle in some general way the problems of nonpoint pollution and in interpreting the provisions of a very complex law.

Other than blatant violations (such as direct discharge of animal waste and chemicals into streams and rivers), control of pollution from agricultural activities has been noticeably lagging. Agricultural uses of water are controlled by state agencies which, at least in most western states, are primarily concerned with water al location, distribution and administration. Concern for beneficial use of water, duty of water use and wastages do not also include the degradation of return flows from overapplication or misuse of water.

Agricultural water quality control has recently become a substantive part of discussions among the various states in the West. Problems ranging from salinity and chemical degradation, sedimentation and other problems associated with suspended material have been examined predominantly from a physical control perspective and technologies have been developed which could alleviate, greatly decrease, or, to a substantial degree, eliminate such problems.

Although the problems associated with irrigation are much more complex and have received much less attention and regulation, their importance both now and in the future becomes evident if one is to examine briefly the role of irrigated agriculture in the United States. Approximately 56 million acres of farm land are currently under irrigation in the United States, with 46.3 million irrigated in 1967, about a 23 percent increase in a ten-year period (Irrigation Journal, 1976). Irrigated agriculture is vitally important to the nation's agricultural enterprise and to the economy as a whole. Although only about ten percent of the total cropped land in the U.S. is irrigated, this land, located primarily in the West, produces approximately 25 percent of the value of farm output (National Technical Advisory Committee, 1968). This results from the more intensive farming practices and higher yields that can be attained on irrigated lands. As the food and fiber needs of an expanding national and world population continue to increase, it is expected that continued irrigation developments will be a central part of the national food policy in the United States.

Although the use of irrigation has enabled this country to provide food and fiber in quantities unequaled in history, significant water quality problems have accompanied these expanding irrigation developments. These problems are of particular concern because irrigated agriculture is the largest consumer of the nation's water resources. In this regard, one should not ignore the challenges of irrigated agriculture in an arid environment, particularly in years of severe drought.

In the context of these general remarks as to the role of irrigated agriculture in the West, an examination of the total quantity and diversity of nonpoint source pollutants, especially in the rural areas, indicate the complexity of the problem that must be faced. It is obvious that simply applying technological solutions is not going to solve the nation's water quality problems. Indeed, more and more it is recognized that many of the gains made in the point source area will not result in cleaner water because of the failure to act in controlling the highly significant nonpoint sources of pollution.

It is here that the National Commission on Water Quality has highlighted the historical asynchrony that has developed between implementation of sections of the Act dealing with point sources alone--Section 201--and point and nonpoint sources together--Section 208. In addition, proposed solutions to problems of nonpoint pollution have been met with substantial resistance, despite economic and social analysis demonstrating the long-range benefits--local, regional and national--that would result from the mitigation or elimination of water quality degradation. The problem here is two-fold. On the one hand there are the physical difficulties encountered in dealing with evasive irrigation return flows wherever they exist. Equally important is a problem of immense complexity, namely the conflicting and competing goals, objectives and priorities of water resources management and overall national water resource policy. There are also a number of factors that influence significantly the strategies for resolving this problem, such as the level of environmental quality desired; the cost of achieving that quality; the equitable distributionof costs; the presumed benefits to be derived from enhancing environmental quality; and, finally, the means for achieving that quality, including the host of economic, legal, political, technical, as well as social constraints.

In spite of the availability of technological solutions to many of the irrigation return flow problems, there has been substantial resistance to change and certainly a noticeable lag in implementation. One of the realistic problems facing decision-makers at all levels (federal, state and water users) is the identification and evaluation of institutional alternatives that can be utilized to unite improved technologies with specific agricultural practices. Some institutional practices may result in lessening the quality degradation from agricultural uses of water and help achieve established goals and standards in water resources management. In many circumstances, however, improved technologies are necessary for the reduction of water pollution, and new or changed institutions are then required for their implementation.

The emphasis of the present approach and the basic argument of the study is to utilize as a backdrop existing technologies and institutions which separately or in combination are useful to the reduction or elimination of pollutants from irrigation return flows. Throughout the discussion that follows, "institutions" are defined as those social mechanisms by which society organizes, manages and directs its affairs. "Institutional alternatives" are the whole range of legal, economic, political, and cultural institutions (or, crystallized ways of doing things) which are used for meeting social needs. The purpose of the analysis that follows is to view the range of technical and institutional alternatives that might be employed in improving quality of return flows, and to "test" them in a number of irrigated areas where there are water quality problems. The central concern of the study has to do with the presentation of specific steps involved in the process of building a basis for implementation of solutions to return flow problems--those solutions being combinations of technological and institutional alternatives.

It is not our purpose to go through the entire range of problems of nonpoint pollution and recommend solutions to all problems. There does exist considerable literature on the effects of specific pollutants of agricultural origin on water resources. Al though, rather few of these studies directly relate sources to water quality, we are assuming throughout the ensuing argument that technological solutions can be found that will be much more amenable to prediction methods relating the nature and extent of nonpoint pollutions to various sources contributing this pollution to water quality.

Another way of expressing the central thrust of the present analysis is to relate it to the quest for a furthering of the decision-making process involved in policies, law, standards, and regulations for pollution control from agricultural uses of water resources. This certainly implies an analytical framework for assessing and evaluating a variety of institutional alternatives and a combination of strategies having to do with an implementation process that will enable compliance with national and state water quality standards as well as with national water quality goals. Given this broad mandate and the emphasis on alternatives and decision-making considerations, the analysis that follows is based on an approach that considers:

a. our understanding of the problem and the extent to which return flow considerations can be intermingled with an implementation perspective;

b. a systematic process which involves identification and generation of alternatives assessment and evaluation of specific steps involved in an implementation process;

C. concrete findings both in terms of substantive steps concerning the process of implementation as well as an initial determination of criteria concerning the development of reasonable alternatives in some characteristic areas of the western United States; and

d. conclusions and recommendations with regard to potential efforts of implementation in the process of meeting the general goal of "cleaner water" or control of nonpoint pollution.

The purpose of the study is to delineate the characteristics of an effective process for implementing technical and institutional solutions to the problem of return flow pollution. The process envisaged attempts to:

a. define the problem in terms of its legal, physical, economic, and social parameters;

b. identify potential solutions in relation to the parameters of the problem;

C. assess potential solutions for diverse situations; and

d. specify those solutions or groups of solutions which are the most effective in reducing pollution and are implementable (building the basis for implementation).

In looking at prevailing conditions, the present EPA permit system seems to fail to adequately deal with the problem of irrigation return flow because it: first,, was developed in the absence of a clear understanding of the problem; and, second, it is strongly resisted by those it attempts to regulate. The process outlined in the study attempts to avoid these difficulties by identifying solutions appropriate to the nature of the problem and by "testing" for the acceptability of these solutions among those affected by them. In essence, the key point is the problem of irrigation return flow quality, not the "permit system."

This report revolves around a combination of technological and institutional solutions through both basic theoretical propositions and practical applications. The argument is presented in six interrelated component parts:

1. The methodology report, which summarizes the overall research approach of the study; the methodological premises; the nature of the problem; the process for identifying appropriate solutions; the assessment of potential solutions; and, finally, some general problems and prospects concerning the process of implementation, particularly the difficulties with implementing controls in agricultural pollution and the theoretical and practical steps involved in building the basis for implementation efforts.

2. An executive summary, which accompanies the main report but which also supports a "slide show" attempting to provide in a succinct form the major findings of the study as well as the propositions involved in the identification, assessment and evaluation of potential solutions concerning irrigation return flow.

3. A "slide show" which exemplifies with characteristic visual help the essence of the argument, the findings of the study, and addresses in a more popular form the types of questions and responses that one identifies with socio-economic considerations relating the spirit of the law to the requirements of implementing solutions for controlling the quality of irrigation return flow.

4. The overall report of the study involves also the use of three case studies and in-depth looks at Yakima Valley, Middle Rio Grande Valley, and Grand Valley, which permit a presentation of the approach utilized as well as specific findings and recommendations relating to the problems of each case study area.

Each of the above parts outlined as part of the total reporting of the study stand by themselves but, ideally, they all reflect concern with the same argument. They should be read in conjunction, but each one of them stands as an independent document.

Returning, then, to the methodology report which is the thrust of the present document, the major sections relate in a theoretical as well as practical fashion the following:

a. the major conclusions of the study, including not only theoretical findings and methodological considerations, but also key findings from the case studies;

b. recommendations as to what can be done in view of the experiences gained and certain concrete suggestions as to the larger problem of water quality control;

C. the research approach used, particularly the methodological premises, the phases of research and the role of the case studies in elaborating and illuminating the basic theoretical propositions advanced vis-a-vis the problems of irrigation return flow quality control;

d. a description of the nature of the problem, especially with regard to the determination of its causes and significance and the basic parameters of the investigation;

e. the process of identifying potential solutions as well as the types and range of proposed solutions with particular emphasis on the need towards combinations of solutions;

f. the process of assessing potential solutions through a "filtering" mechanism based also on field assessment; and

9. a general discussion and selected remarks as to the process of implementation with particular emphasis on the attributes of change, the process of innovation and diffusion, and the challenge of implementing changes in agricultural pollution control efforts.

SECTION 2

CONCLUSIONS

Recognizing the thrust of the present study as the process for implementation of technological and institutional solutions to return flow quality problems, the following conclusions summarize the central findings:

1. At the heart of the problem is the institutional arrangement for allocating water, i.e., the water right which ordinarily bears little relationship to need and/or beneficial use.

2. The most appropriate solutions deal with the diversions and uses of water rather than treatment of irrigation return flows, i.e., effective solutions deal with causes of pollution, not the pollution itself.

3. Solutions mutually beneficial to all other users of water and the farmers are most implementable, e.g., publicly subsidized on-farm physical improvements; provision of technical assistance in water markets, water rental markets which cause allocation of "surplus" water to nonfarm uses.

4. Various means of improving on-farm management of water are favored by persons closely related to irrigated agriculture.

5. Irrigation districts play a major role as part of existing organizations in implementing solutions to return flow quality problems.

6. Informational and educational programs to assist individual farm operators must be instituted early; be imaginatively conceived; and be continuously monitored, modified and upgraded if motivation for change is to be encouraged.

7. There must be a clear definition as to who has authority, control and responsibility for specific tasks associated with irrigation return flow quality control.

8. Major technological breakthroughs should not be relied upon for providing return flow control; instead, emphasis should be on a combination of current technologies and of institutional arrangements.

9. Statewide and regional advisory committees have been indicated as useful parts of the continuous effort for cooperation, coordination and combination of efforts and resources.

10. Technological alternatives for improvement should be utilized with sensitivity to local conditions and as part of a slow, iterative and long-range process of implementation.

11. Credibility and trustworthiness of federal and state agencies in the eyes of water users provide the important final ingredient in understanding the need for change; in motivating individuals for accepting appropriate solutions; and, in creating a climate of cooperation and credence as to the need and ultimate usefulness of a larger social policy concerning “cleaner water.”

SECTION 3

RECOMMENDATIONS

The recommendations of the project are more relevant to the circumstances of the case studies. Generalizing from the recommendations of the case studies, the following points supplement key recommendations from the study:

1. Studies should be undertaken to evaluate the downstream damages due to water pollution. Such studies would delineate the distributional impacts of benefits and costs from measures to improve irrigation return flow quality in order to develop more exact standards of cost-sharing. In essence, the share of the burden between the farmer and society should be more accurately evaluated in order to arrive at a better estimation of whether the farmer should pay the full cost, or the government should share the eventual cost.

2. Given the first recommendation, solutions to problems of irrigation return flow quality control should deal with causes and not symptoms. This means tracking the ultimate conditions that result in water degradation, especially through a careful analysis of the provisions of the legal system and the creation of a market and other institutional mechanisms that could reach the roots of the problem rather than the manifestations of it.

3. A water management improvement program should be implemented to include the following components:

a. system rehabilitation to allow timely and accurate delivery of water so that existing constraints to better on-farm water management may be removed;

b. an irrigation scheduling service to allow farmers optimal quantities of water for crop production to be applied with a minimum of waste;

C. measurement of irrigation water to the farm to allow the application of the desired quantity of irrigation water; and

d. a change in irrigation methods in some cases (e.g., trickle irrigation for pecans, sprinkler irrigation for field crops) to reduce consumptive use and waste due to nonuniformity of water application.

4. In terms of implementability, the most acceptable methods are those for which we have most control. In this respect, inappropriate solutions are those that are superimposed on the system and are not part of local control. Local solutions areneeded which maximize implementability and are sensitive to the problem at hand, and which may also require the creation of new institutions. Whenever possible, existing institutional bodies should be utilized rather than superimposing artificially conceived organizations.

5. There must be greater participation by the farmers and users in order to enhance the feeling of joint action, involvement and attitudes of democratic decision-making. This implies that the implementation efforts are part of a communitywide basis and of a total involvement rather than part of handed-down solutions imposed upon the water user.

6. It is important to expand demonstration projects in order to incorporate institutional "solutions" on a basinwide basis and attack the problem through a more holistic approach, rather than only through technological measures. However, while the demonstration project should be on a basis that would be wide enough (perhaps a district or a region) it should not encompass such a wide territory as to lose its effectiveness as a demonstration project.

7. The approach towards implementation should be based on a determination of the ability of the farmer to solve the problem as well as of the capability of the government to promote irrigation return flow quality control. A balance must be reached between the ability of the farmer and the capability of the government in order to provide a mix of implementing measures that utilize both motivational reinforcement and administrative enforcement.

SECTION 4

THE RESEARCH APPROACH

METHODOLOGICAL PREMISES

The study undertaken by the interdisciplinary team has attempted to further the public and political decision-making process concerned with the problem of quality degradation in agricultural return flows. In outlining the thrust of such an approach, the following interrelated objectives have been identified as necessary:

a. the description of problems of water quality caused by irrigation return flows in a particular area;

b. the identification of appropriate technologies and the institutional alternatives that together may improve irrigation return flow quality control;

c. the assessment of combinations of technologies and institutions as to their feasibility of implementation in selected areas in the West, through field responses and community feedback; and

d. the analysis of the process of change and of decision-making as a basis for eventual efforts of implementing return flow quality control.

To achieve the proposed interdisciplinary study, four areas were selected in the western United States within which the conceptual and methodological approaches to the studies were applied. These included Yakima Valley, Middle Rio Grande Valley from Elephant Butte Reservoir to Fort Quitman, Texas, Grand Valley, and San Joaquin Valley. Such an approach allowed a combination of both theory and practice and contributed to the development of both general and specific recommendations for programs implementing institutions and technologies for improvement of irrigation return flow quality control. The first three areas were studied in detail, while the last one (as it will be indicated later) was used only as an additional source of information for outlining general problems in return flows.

Essentially, in the proposed approach, there are five interlocking steps in a process of cumulatively building experience with the problem and of providing an analytical framework for evaluating technological and institutional alternatives. These steps include:

1. Problem definition.

2. The investigation of those institutions and technologies which could control quality of irrigation return flow and the assessment of their impact on the problem.

3. The generation of alternatives or the identification and analysis of various technical and institutional solutions to problems of quality control.

4. The assessment of those alternatives and a critical analysis of total system effects of criteria for weighting alternatives.

5. Evaluation through the help of affected recipients and a juxtaposition of feasible strategies and of programs of quality control.

Thus, the major effort in this study was of building a basis for implementation in a dynamic process of definition, investigation, analysis, and evaluation of alternatives and an understanding throughout this process of key factors which may hinder or facilitate adoption and sustained use of "solutions."

The general objectives outlined above have to be understood in the context of a broader approach that involves four critical dimensions as outlined in the descriptive dimensions of Figure 1. First of all, a major dimension has to do with the delineation of the problem boundaries and the determination of the irrigation return flow quality control dimensions (1). The second part of the analysis involves the provisions and the legal imperatives outlined in P.L. 92-500 (2). The third has to do with the "recipients," i.e., affected parties and the related organizational preparedness for new institutional arrangements or rearrangements (3). Finally, the last part has to do with the preferred course of action, or "the solution" which is described as the "fit," constituting the combination of technological and institutional alternatives aiming at reduction of problems of irrigation return flow (4). In other words, what we have in this impressionistic figure are the key elements of our approach, i.e., the degradation of water from a variety of agricultural use pollutants; the law; the affected parties; and, the "solution."

In such an approach, the problem bounding of the irrigation return flow quality control problem reflects the physical parameters and particular conditions and uses of a given problematic situation of agricultural pollution (2). P.L. 92-500, which demands that the problem be remedied, is represented by the circle (2) overlapping with the boundaries of the problem. This results from the fact that not all of the law is necessarily applicable to irrigation return flow quality control problems. The same argument pertains also to recipients of effects (3), both affected parties (groups or individuals) and organizations (in terms of their preparedness for change). Obviously, part of parties and organizations fall within the boundaries of agricultural pollution; but, at the same time, part of them are outside the particular boundary of the problem (in both spatial and aspatial terms). It should be noted here that institutional preparedness implies what the social

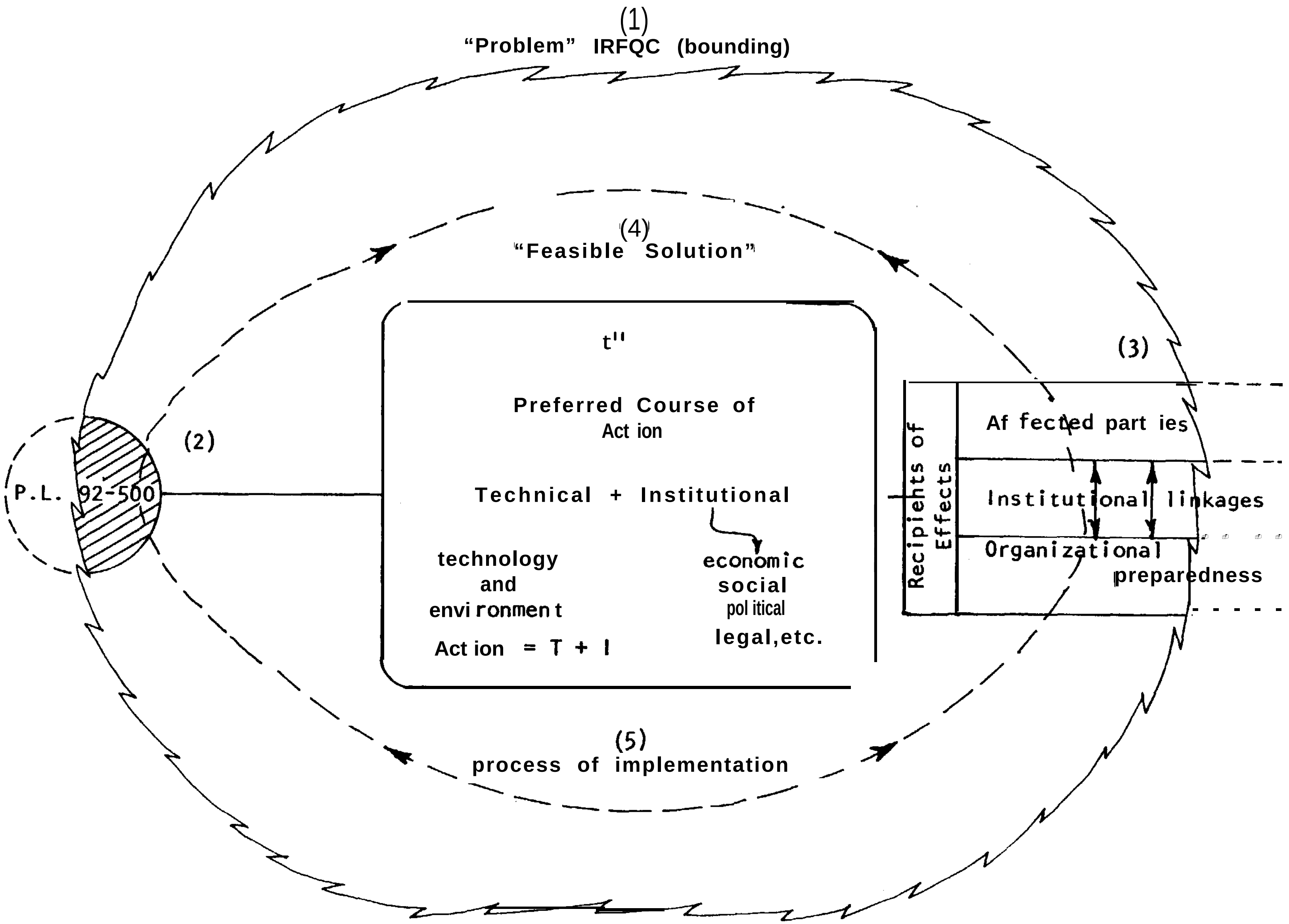


Figure 1. Critical dimensions of problem analysis.

system can do with regard to the problem of irrigation return flow quality control. Within that institutional framework and with consideration of affected parties, one can trace consequences of the law. Institutional linkages place individual recipients within the organizational framework. It is such a framework which to a large extent determines the degree and type of effects that the individuals will be exposed to.

Given these three major dimensions--the problem, the law, and the recipients--the next step is to investigate those "solutions" (hardware and software) which singly or together may control irrigation return flow. There emerges what we roughly have described as the "preferred course of action," or in a simpler form, the "solution" (4). Such a "solution" takes into account the conditions of the situation, the technical and institutional parameters, and arranges all such elements in such a way as to meet the spirit of the law. ideally, such a procedure would allow the best possible "fit" of the law and affected recipients in order to achieve shared goals of return flow quality control. The "solution" to the problem of irrigation return flow quality control is to maximize the compatibility of the mandate of the law with the desires of the recipients as related to effcient and effective agricultural production. In this simplistic interpretation, a "feasible solution" standing between the law and the recipients should act as a "pull" bringing together these two poles of presumed similiar interests, namely, increased agricultural output and "cleaner water."

This process of integrating the provisions of the law with the desires of the recipients leads to further consideration as to implementing a "feasible solution" by keeping in mind three critical questions:

1. How is the preferred course of action arrived at (developing feasible or balanced solutions)?

2. Once that preferred course of action is obtained, how can it be integrated into the social system?

3. Given the first two dimensions, what are the conditions for exercising, monitoring and reevaluating this particular course of action (administration)?

What we are saying is that the process of implementation represented by the dotted lines of Figure 1 brings the objectives of the law and the desires of the recipients closer together in a compatible and negotiated scheme whose ultimate aim is the proper solution of problems of pollution and irrigation return flow quality control, leading to "cleaner water."

Implicit throughout this general scheme of bringing together legal imperatives (policy) and affected parties (implementation) are a number of underlying concepts from social psychology. These concepts can be all subsumed under the process that may be briefly labeled as that of "bracketing" (also "screening" or "filtering"). The common characteristic of all such broad concepts is the attempt to incorporate the notion of congruence or compatibility. Rather than discussing further all such concepts, we may use the categories in Figure 2 in order to summarize the presumed differences in the continuum from knowledge to information and adoption and implementation.

Figure 2 assumes two levels of analysis. On the individual level there may arise what has been identified in the literature as “cognitive dissonance.” In the present context, this concept indicates the discomfort experienced by persons when they perceive that various phenomena are inconsistent with one another. In such a case, individuals are motivated to seek balance “in order to get their world in order again.” The concept of cognitive dissonance on the individual, or socio-psychological, level is important in order to understand the disparity, between the individual user’s understanding of what the implementation of irrigation return flow measures may do and his understanding of how the world around him really is. On the other hand, on a more macro level or on a societal level, we may understand the disparities or disagreements as part of what we may summarily label “structural strain,” indicating the difference between the noble principles of the law and the inability of institutions to stretch and accommodate proposed changes or implement desired policies.

The implication from such potential sources of incompatibility is that the solution of cognitive dissonance leads to consensus validation, while the resolution of structural strain leads to what may be called “socio-cultural compatibility” (i.e., the agreement between what the law implies and what the law in the actual case is capable of doing). Thus, the resolution of both individual cognitive dissonance and of institutional structural strains leads ideally to <u>congruence</u> through steps and measures that they are not only appropriate but also acceptable and feasible under the realistic constraints of given circumstances.

The above considerations point out that often there may be a pronounced gap between proposed policy actions and efforts for implementation. Later on there will be further discussion of the theme as to how this gap can be closed and how compatibility between what is proposed and what can be implemented can be achieved. It is important to notice that this gap between proposed policy actions and actual implementation efforts may be due to many factors such as the lack of appropriate roles; the lack of a larger normative structure; the lack of institutional linkages and mechanisms; and, above everything else, lack of resources.

The brief remarks made above about socio-psychological and societal level efforts for compatibility or congruence point out that underlying any type of decision-making and implementation effort is a <u>conflict</u> model that postulates how patterns for coping with decisional stress are processed by both decision-makers as well as affected parties. The dissonance or lack of congruence become, then, part of a variety of coping patterns in conflict resolution, ranging all the way from unconflicted adherence to defensive avoidance (such as procrastination, shifting responsibility, or bolstering); to, finally, vigilance which has been defined in the literature as a discriminating search with open-mindedness involving a serious examination of all risks involved, including the belief that eventually a satisfactory solution can be found and that there is sufficient time for search and evaluation before a commitment to a particular policy is to be made.

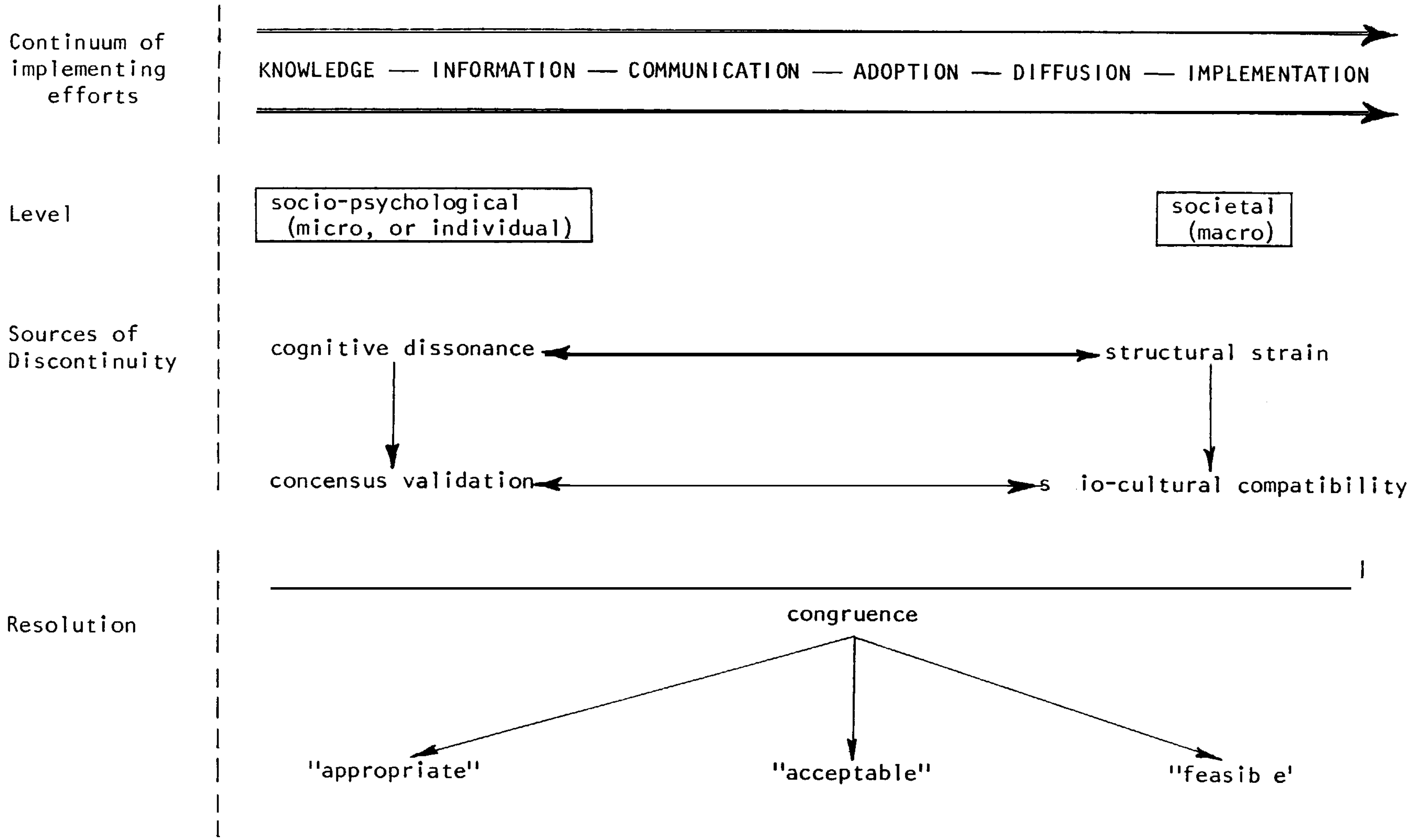


Figure 2 Potential individual and societal incompatibilities in the implementation process.

Conflict resolution, therefore, involves a very elaborate scheme beyond and above what appears on the surface as a simple process of bringing together the precepts of the law with the desires of affected parties. In addition, there is also post-decisional conflict which aims at undoing or reversing a particular decision or policy. Thus, a decisional crisis may appear at even a later stage having to do with either the effort of undoing the decision; or a compromise in the form of partial implementation; or, a reaffirmation of the original decision if the conditions foster through political maneuvering an eventual agreement with the original purpose of the policy action (especially if the benefits to be derived are further explicated and the risks do not seem particularly prohibitive).

The above brief exercise into some basic concepts involved in identifying a particular problem, developing alternatives and in assessing and evaluating solutions can show how far-reaching and difficult are the set of circumstances that are associated with the implementation of a given policy act ion. These remarks will be further elaborated with concrete examples in Section 8, where an attempt is made to outline the process of implementation by concentrating on problems and challenges associated with the attributes of change and with the process of innovation, diffusion and implementation.

It is important, however, to return to the basic premises characterizing the quest for improved water quality. The premises of the present study and the key elements that are driving the search for a solution emphasize: a) a basic preventive approach (enforcement as an exception); b) public participation and involvement (voluntary compliance emphasis); c) flexibility and adaptability (solutions being site-specific and culturally sensitive); d) technological efficiency (technically appropriate solutions); e) organizational preparedness and interrelationships among all affected parties; and f) credibility and believability of proposed alternatives and strategies.

The above are only some of the central assumptions that can serve as philosophical underpinnings of the search for building implementable strategies for irrigation return flow control. It is in the context of such broad assumptions that we need, then, to delineate and evaluate a consistent approach for reaching shared goals of “cleaner water.”

The key problem, at this moment, is to incorporate in all the above dimensions, discussions and objectives and in the general parameters of the problem, a set of operational questions in order to demonstrate how cooperation and coordination through appropriate solutions can build integrated strategies of change; or, in the spirit of Figure 1, how we bring together problem, “solution,” process of implementation, and administration with regard to return flow problems. These operational questions exemplify in a very specific form the emphasis of the present research on two different levels. On the one hand, the study is concerned with an overall scheme and conceptual integration of the dimensions of an implementation process. On the other hand, we want to refer to specific problematic situations in each of the case study areas proposed. What we have, then, are questions of research procedure dealing with the dimensions of “the solution,” through some general theoretical discussion of how one arrives at some form of “optimum fit.” At the other end, pragmatic questions analyze specific parameters of a concrete problem situation. To avoid further abstract elaboration, key questions include:

1. Questions of Research Procedure

"SOLUTION:" General

Identify procedures for arriving at the most preferred course of action (combination of technical and institutional alternatives).

Specific

Identify specific situational points (solutions) in each case study area.

IMPLEMENTATION. PROCESS: General

Describe the basis of the theory of innovation-diffusion, the nature of the fit of the solution, and the process of public participation.

Specific

Delineate in each area the feedback, organizations that can be used for implementation, channels of communication, etc.

2. Pragmatic Questions.

While the above have to do with a more or less abstract approach, pragmatic questions concentrate on potential courses of action. While such questions are also concerned with the law, the recipients and the feasible solution, their emphasis is on "what next," or what specific insights have we gained. Central among them are:

- Should the law be changed?
- Should the administration of the law be changed?
- If yes, how? (For example, by reinterpreting what proper provisions of the law are conducive to irrigated agriculture.)
- What do people prefer?
- What is the compatibility between the people's preferences and the law? (Such as the degree of their relationship, the extent of communication, sensitivity to mutual demands, etc.)
- Recognizing that there are means for reducing irrigation return flow, how does one implement the solutions? (What are, e.g., the specific steps for a timely and orderly transition to new requirements?)

Certainly, it is impossible to answer in an exact form all such realistic and everyday questions concerning implementation of legal requirements. At this point, and without elaborating in advance a longer argument, our contention is that it is not the law that needs to be changed, but its administration, particularly through reinterpretation, careful testing in specific cases, and gradual process of change.

Perhaps it is appropriate at this point to turn back and underline the issues raised in the previous pages. The essence of our argument is the establishment of a "fit" between the law and the recipients of that law. Thus, a "solution's" purpose is to integrate the law with the recipients' desires through appropriate institutional linkages.

Another way of looking at the approach of the study is through an evolving assessment process summarized in Figure 3. The key element in this particular figure has to do with the search for a balanced decision that would provide the best solution ("appropriate solution") to the dissatisfaction from agricultural pollution (as mandated by the law or becoming apparent in the surrounding environment).

By using this type of an approach and through continuous interaction among members of the research team, a consensus as to critical findings has been established. The concern throughout the conduct of the study has been to provide concrete validation of the theoretical processes described above, and, at the same time, through interaction both within the team as well as with water users in the particular areas of concern, relate to actual circumstances the critical findings concerning solutions, constraints to implementation, and the basis for developing strategies for controlling irrigation return flow.

The problem does not reside exclusively on the determination of an "appropriate solution," although the last has been a central point in finding out what really can be done to communicate effectively the spirit of the law with regard to problematic situations in a variety of cases in the western United States. The concern begins with the process of <u>arriving at</u> appropriate solutions, in <u>assessing</u> in an interdisciplinary manner alternatives, and in <u>outlining</u> the steps for an eventual process of implementation of whatever is the agreed-upon "solution" or program.

It is important to underscore again the centrality of the search for an "appropriate" or "balanced" solution. A key element and assumption of the study has been that such a desired "appropriate" solution can be reached by considering through an interdisciplinary analysis a variety of factors that bring together what is technically sound, economically viable, legally pertinent, socially acceptable, and, finally, what is politically feasible or implementable. This search for the combination of a wide spectrum of conditions leading to the "appropriate solution" is articulated in the categories of Figure 4.

In the present study, we considered such criteria in an abstract as well as in a practical form (theoretically as well as through field experience) in order to reach what is a balanced solution given certain technical, legal and socio-economic conditions (Figure 5).

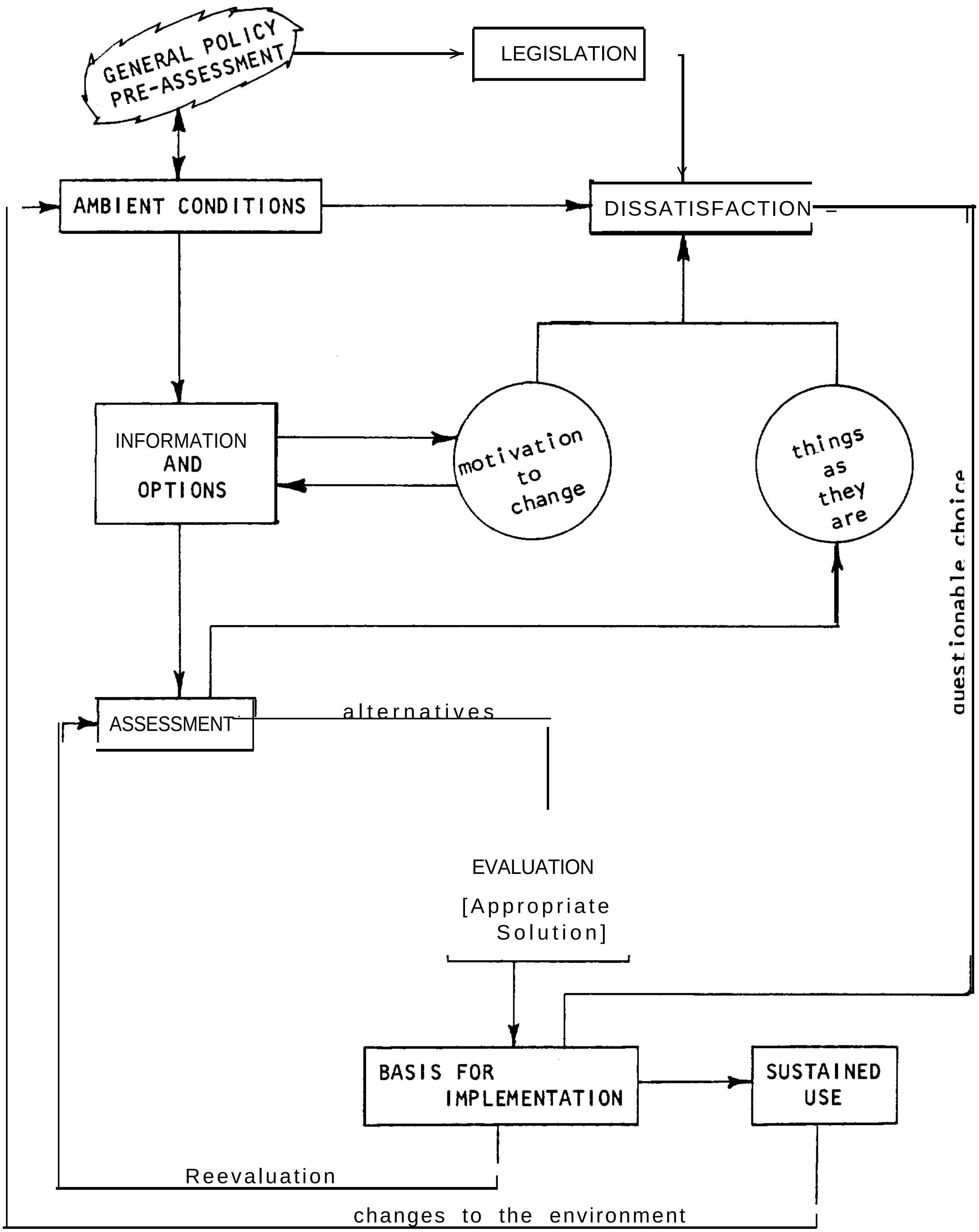


Figure 3. Building the basis for implementation.

APPROPRIATE SOLUTION

- Technically sound
  - Technologically practicable
  - Long-term benefits vs. short-term gains
  - Ecologically non-damaging
- Economically viable
  - Economically achievable
  - Providing efficient resource allocation
  - Promoting equitable distribution
- Legally pertinent
  - Protects vested rights (due process)
  - Complies with legal criteria in substantive law
  - Complies with administrative procedures
  - Promotes beneficial use concept
  - Is characterized by flexibility & predictability
- Socially acceptable
  - Congruent with current practices
  - Consistent within cultural context
  - Compatible with organizational ional structure
  - Corresponding with desires of people
- Politically feasible
  - Compatibility of interests (local/regional/national)
  - Establishes priority of problems
  - Compares severity, intensity and magnitude of potential effects
  - Aims at constituency satisfaction

Figure 4. Key characteristics of an appropriate solution.

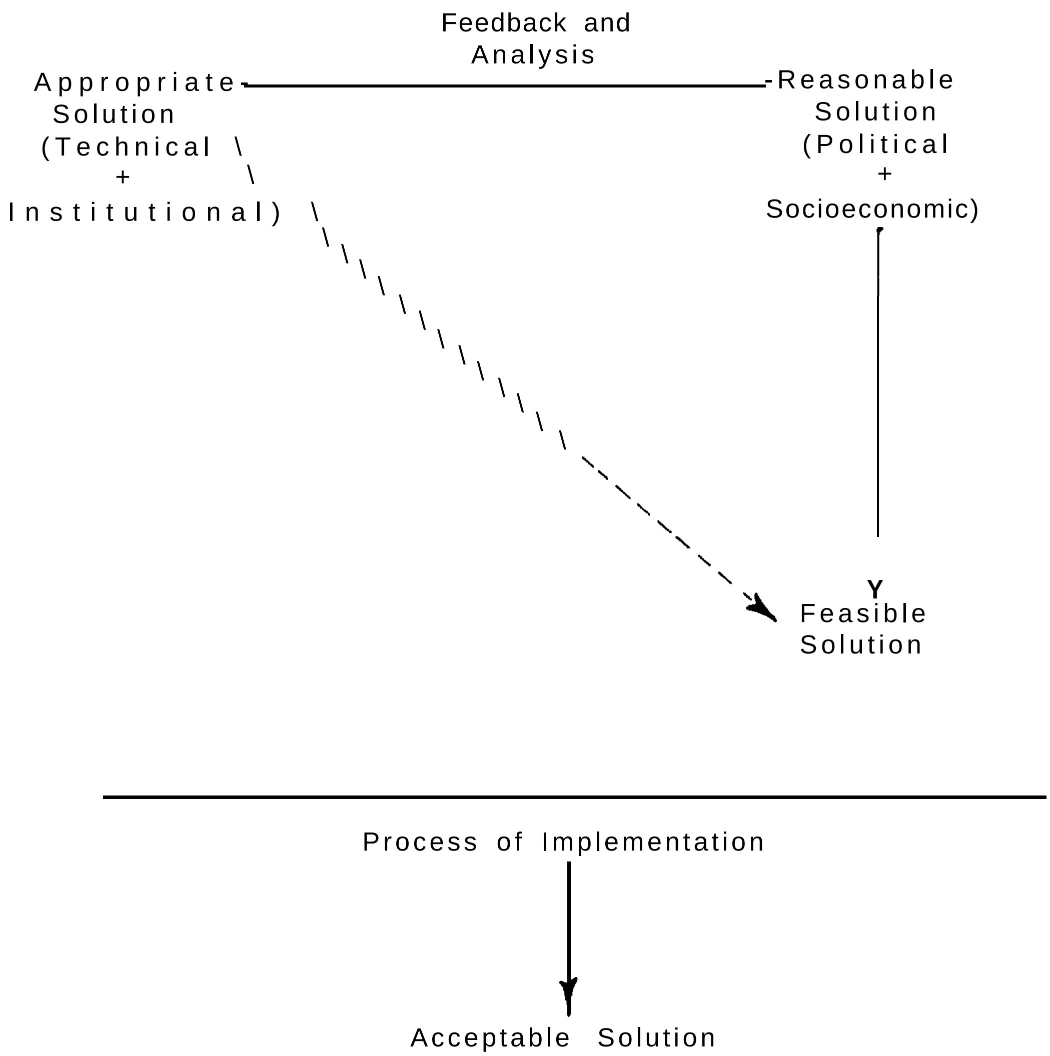


Figure 5. The search for acceptable solutions.

What the above imply is that in studying the technical and institutional conditions of a given problem area, an appropriate solution (through interdisciplinary analysis) may evolve. However, that generally or theoretically arrived-at appropriate solution must be imbedded in a political and socio-economic context in order for that solution to be a "reasonable" one compared to combinations of other solutions or program strategies. At this point, through an assessment and evaluation procedure, a "feasible solution" can be considered. This solution is introduced into the social system via a dynamic process of implementation, which when institutionalized becomes the "acceptable solution" to the original problem of return flow quality control.

In order to further explicate this approach and, at the same time, summarize the central argument of our study, the key dimensions shown in Figure 6 may be used. In this summarizing figure, the sequence of the study approach involves:

a. setting the stage, bounding the problem and considering potential solutions;

b. arriving at appropriate solutions and determining alternative strategies; and

C. building the basis for implementation and facilitating the acceptance of appropriate solutions.

Figure 6 outlines also particular aspects or dimensions in each of the above phases. Each of these subdimensions has been intensively analyzed as part of the desired interdisciplinary synthesis aimed at building the basis for implementing a given solution (or, for relating <u>appropriate</u> to <u>acceptable</u> "solutions"). In addition, Figure 6 underscores the iterative steps, involved in such a process. In implementing an appropriate solution (in making it acceptable), monitoring and feedback may allow the problems to be <u>redefined</u> (reexamine the stage, critical variables, law, or affected parties); appropriateness of the solution to be <u>questioned</u> (especially with regard to trade-offs and local sensitivity); and the acceptability of the proposed solution to be <u>reexamined</u> in terms of the degree of local involvement, availability of implementation mechanisms and coordination between all responsible agencies.

In summary, the process of implementation brings together the objectives of the law and the desires of the recipients in a compatible, complementary and negotiated scheme whose ultimate aim is the proper solution of problems of pollution and irrigation return flow.

The essence of the approach developed is that the problem requires consideration of a number of alternatives leading to some solution. The process of implementation brings together problems and solutions, as well as an assessment of the various alternative strategies. This process is based on a juxtaposition of a set of assumptions and of related programs as outlined in the following manner:

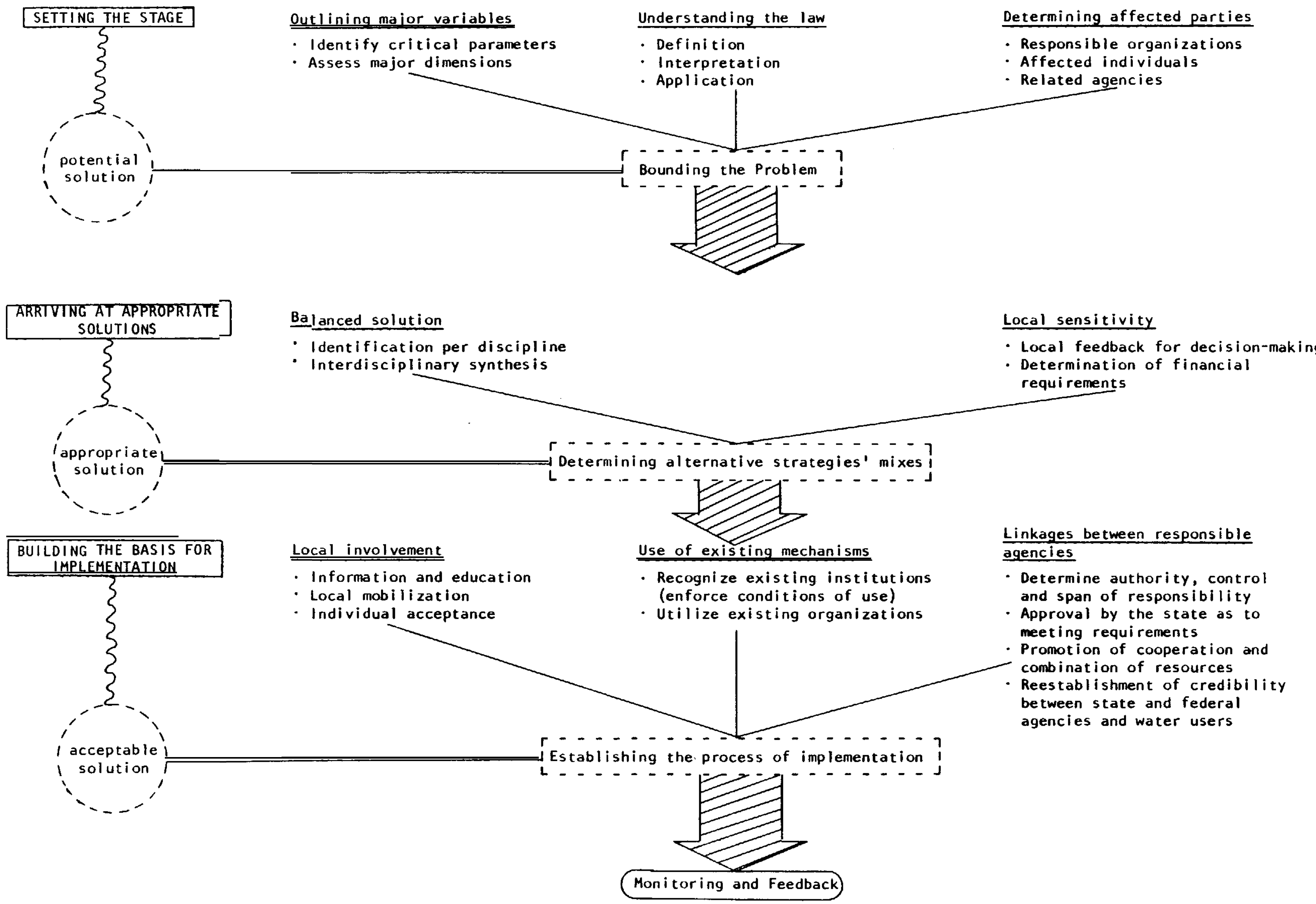


Figure 6. A sequential paradigm for building the basis for implementation.

Assumptions	Examples of Intervention	Program
- Improved Agricultural Practices	* Incentives	- Best Agricultural Practices
+	*Market mechanisms	+
- Improved Water Management	'Legal enforcement	- Best Management Practices
+	*Centralized demands	+
- Public Acceptability	'Etc.	- Public Mobilization

The key problem in this study was not so much the repetition of the conditions in the areas of concern that may hamper or facilitate potential change and implementation of new technologies (although this is a necessary part of the problem); but, the focusing upon very specific strategies- and tactics required for a dynamic process of effecting change. The important aspect is to develop a paradigm as to how specific features of an implementation process can be outlined and, at the same time, formulate a particular plan for improving irrigation return flow quality in areas of concern.

PHASES OF RESEARCH

The previous discussion points out that the central problem in the study was the evaluation of potential strategies in building the basis for the implementation of a variety of institutional arrangements that make possible effective utilization of technologies for irrigation return flow quality control (IRFQC). IRFQC is seen primarily as part of a dynamic process involving description of the problem situation; analysis of technological and institutional alternatives; assessment and evaluation of combinations of solutions; and definition of the basis for an implementation process which may lead to the accomplishment of stated goals. Thus, the research revolves around four major phases:

a. systemic mapping or problem description;

b. identification of potential solutions or generation of alternatives;

C. assessment and evaluation of potential solutions; and

d. the building of the basis for implementation.

The overall approach and the steps of the unfolding process are summarized in Figure 7. Around these general categories of concern, the following specific four phases (which also head Sections 5, 6, 7 and 8 that follow) become the guiding principles of the specific conceptual and methodological consideration throughout the study.

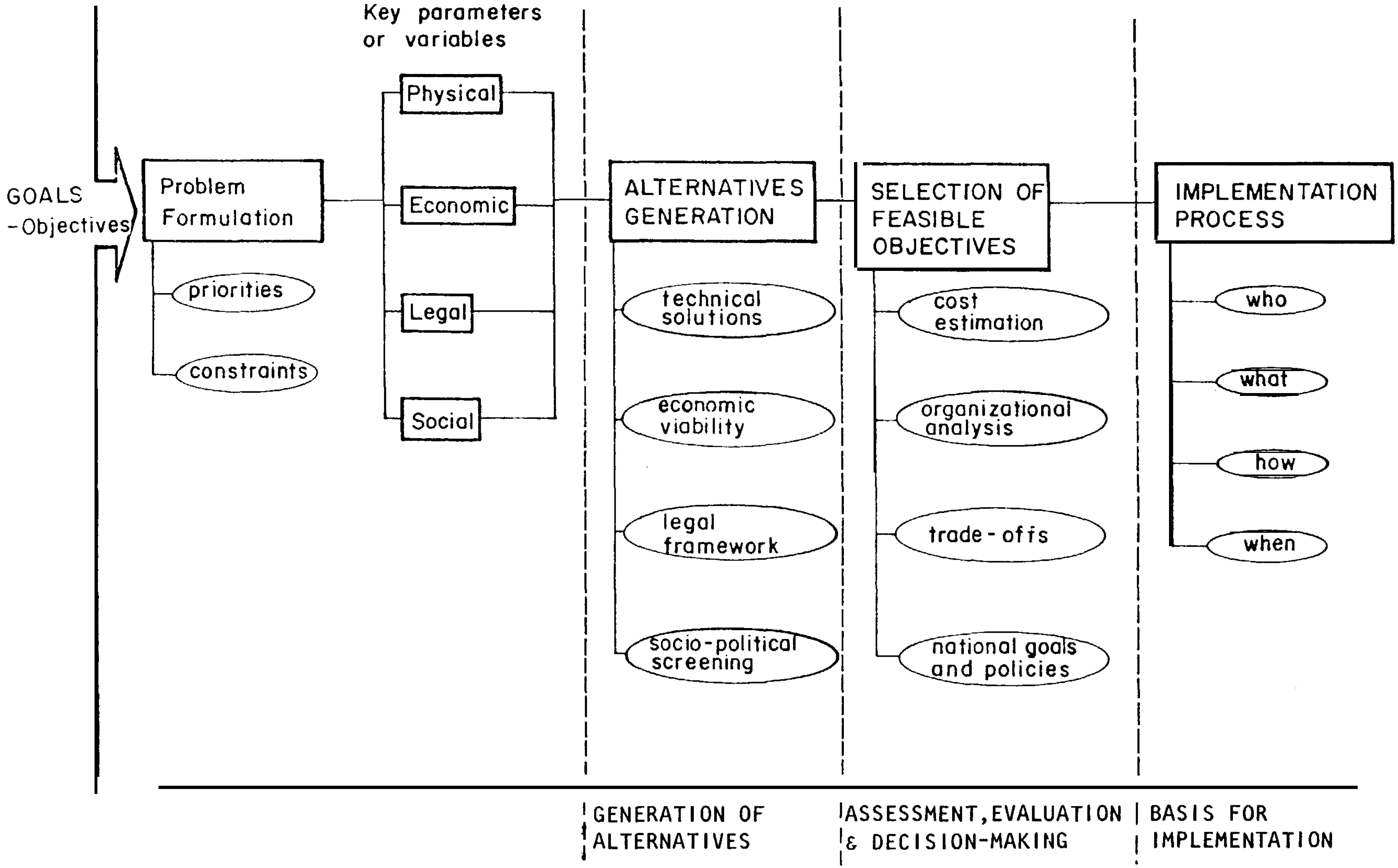


Figure 7. Conceptual framework for proposed research.

1. Systemic mapping, or problem description. An initial part of the study was devoted to a specific problem formulation. This involved a delineation of physical and socio-economic circumstances in each geographic area of concern, determination of severity and intensity of quality return flow problems, and perceived need for change. Utilizing predominantly existing data and series of site visits, the interdisciplinary team provided a delineation of critical variables through a description of physical, technical, economic, legal, and social dimensions characterizing the surrounding "environment" of the areas under examination.

2. Generation of alternatives, or identification of potential solutions. With the establishment of a realistic background having to do with concrete data and problematic situations in areas of concern, a next phase involved the identification and analysis of various technical and institutional solutions to problems of water quality control. This phase of research incorporated technical design requirements, the economic viability of proposed technical solutions, institutional alternatives, and the socio-political considerations which are necessary for choices among technical-institutional alternatives and solutions of the problem at hand. At the same time, a number of initial screening mechanisms were established by concentrating on such dimensions as:

a. the types of potential project intervention (such as the combination of hardware and software solutions);

b. the definition of system boundaries and functions (such as communities affected, services provided, goals to be achieved, etc.); and

C. technical design requirements (especially the explication of appropriate technological innovations).

3. Assessment of potential solutions. This phase was concerned with the selection and assessment of feasible alternatives within the framework of goals and policies, and with appropriate strategies for considering a potential implementation of chosen alternatives. In particular, this phase provided the basis for critical assessment of the total system effects and criteria for weighting alternatives for problem solution. It is at this particular phase that the assessment of potential solutions provided also the possibility for direct contact with decision-makers and water users at various levels for project areas that served also as confirmation of theoretically conceived alternatives. The key problem was to explicate the need for a meeting ground that would permit all affected parties to express their unconstrained opinions as to the nature and feasibility of the proposals for problem solution which were set within certain established standards for quality return flows.

4. Building the basis for implementation. This last phase constituted a core argument that by necessity had to remain rather theoretical. This phase concentrated on some initial remarks as to the management of implementation efforts; the designing of appropriate steps for effective implementation as well as the timing of change; and, finally, on a

recapitulation of the dynamic character of the process of implementation which begins exactly with the steps outlined above, i.e., with a detailed description of the nature of the problem and the identification and assessment of potential solutions through all affected parties.

Looking back at the four major phases that characterize the general research and which were also the guiding lines for a detailed examination of each case study, one should underscore the sequential scheme of a progressive but mutually reinforcing cycle of problem description, identification of potential solutions, assessment and building the basis for implementation. Thus, by determining the basic physical, economic, legal, and social conditions which contribute to the problem of water quality degradation, it becomes possible to develop solutions that deal with a combination of causative factors, rather than by merely referring to symptoms. Given the thrust of this research, the emphasis throughout rests on the assessment of potential solutions through field assessment in order to arrive at a concensus of packages of appropriate solutions; evaluation of acceptable approaches; and, finally, on the building of a credible process of implementation through a combination of what is theoretically sound, realistically practicable, and socio-economically attainable. In this regard, we are also describing a process of “specification” with a number of associated concepts, such as summarized in Figure 8.

Throughout the study, it was assumed that following the identification of potential solutions for return flow quality problems, appropriate solutions would be more or less acceptable (and thus implementable), depending on their impacts on the affected parties. Field assessment procedures were devised to determine technical, economic, political, and social acceptability of alternative solutions. These procedures involved assessment and evaluation by: a) the project team; b) state and federal agency personnel; c) irrigation water management; and d) water users. The field assessment of potential solutions provided a realistic backdrop against which further sharpening of the range of alternatives, their advantages and disadvantages, could be pursued.

The field assessment of potential solutions, being such a central point, needs a bit of further elaboration since it became a central feature of the analysis of material in the case studies. A first evaluation was conducted by the project team. Composed as it was of engineers, economists, sociologists, and an attorney, the team was able to judge alternative solutions in terms of the criteria of general technical, economic, legal, and social feasibility (along the characteristics suggested in Figure 4). Inappropriate and ill-advised solutions were immediately weeded out, though their number was not great to start with. Alternatives with potential for significant impacts on the quality problem and those without prohibitive costs were left for evaluation by others. The team wanted to present the widest possible range of alternatives to succeeding evaluators and to the field for “testing” as to their appropriateness, feasibility and acceptability.

A second evaluation was accomplished by federal and state agency personnel, chiefly those presently or prospectively involved in administration of quality improvement programs. The alternative solutions were thus screened

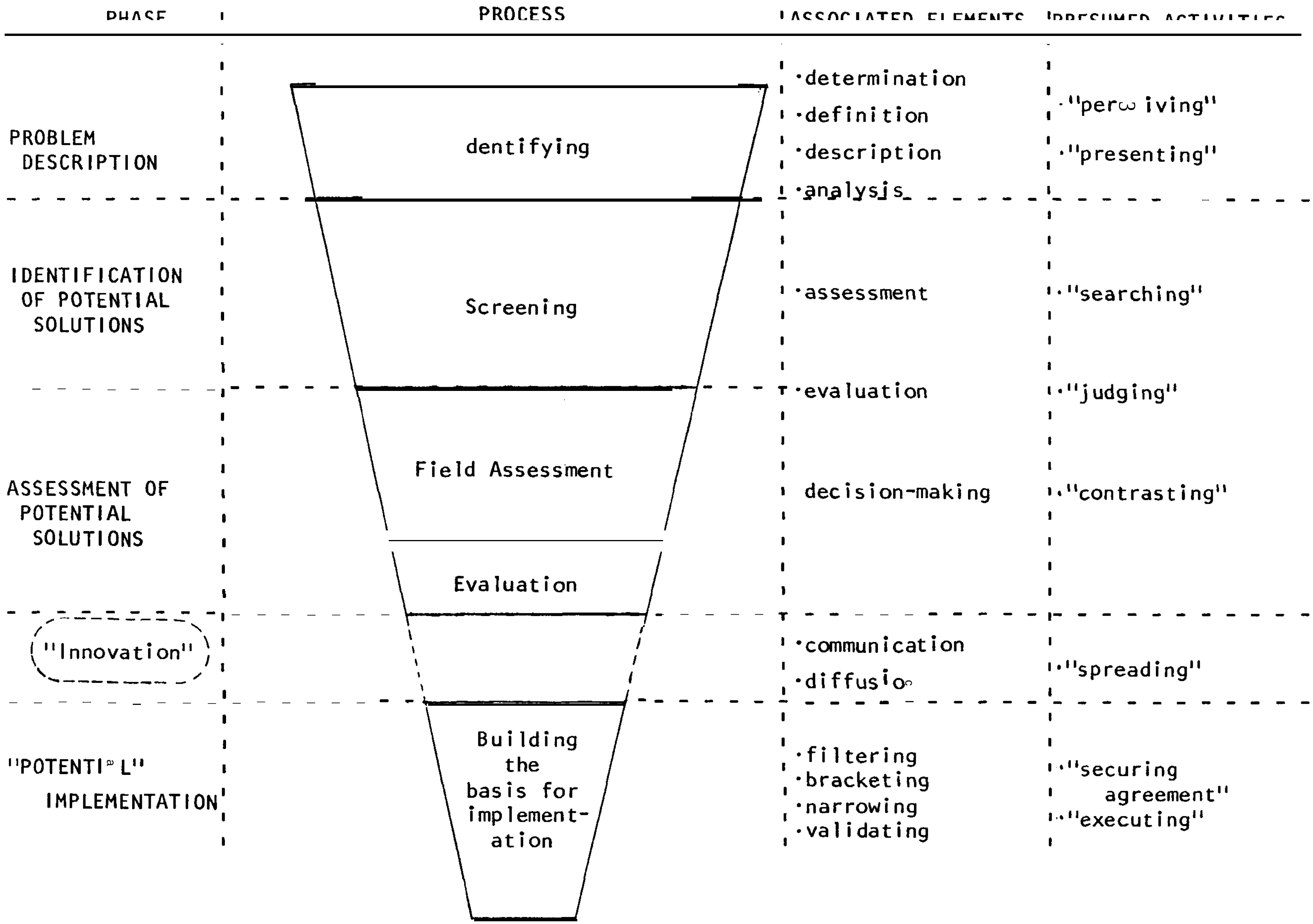


Figure 8. Specifying the process for building the basis for implementation.

by those with technical and legal expertise, a group with a special concern for administration of laws and programs. This group tended to sort out those solutions which did not fit within the framework of existing laws, rules and regulations, and which would, therefore, be difficult to implement, The list of alternatives was reduced, but not so as to exclude some solutions which would be possible with changes in laws, rules and regulations.

A third evaluation was completed by managers of water supply agencies (e.g., irrigation companies and districts) and their boards of directors. These were individuals having responsibility for distribution of water among farms of members and patrons and for maintenance of system facilities. Because they are potentially responsible for administration of revised rules governing diversions and use of water, they tended to resist measures of control. But they were aware of water quality problems; they were generally convinced of possibilities for improved use of water; and they tended to favor quality control measures located and administered at their level rather than at higher or lower levels.

Finally, a fourth evaluation was done by users of water, i.e., farmers who use water in irrigation of crops. They were interviewed individually. During the interviews, there were extensive discussions as to return flow quality problems and as to potentially useful solutions. These individuals, though alarmed by present efforts to control their use of water, showed both ability and willingness to comprehend problems of water quality and to deal with them. They were very practical in their judgments of implementability of the various alternative solutions, and they generally tended to favor those measures aimed at improved use of water in agriculture. Obviously, these were the types of measures and solutions over which they had some control.

The alternative solutions proposed for evaluation ranged from those which were wholly technical (e.g., rehabilitation of distribution systems) to those which were purely institutional (e.g., creation of water markets). Some were combinations of technical and institutional measures which would cause improvements in quality of return flows (e.g., cost-sharing arrangements for improved irrigation facilities). They can be generally classed as a) those which were concerned with the effluent, i.e., the return flow; b) those concerned with the influent, i.e., the water diverted to agriculture; c) those associated with the management of land and water on farms; and d) those directed to sources of water, i.e., generally those which would increase supply.

The assessment process and especially the field “testing” contributed to an iterative character in that it involved the mutual education of those performing the testing as well as those being tested. In this regard, the testing process is not one of determining absolutes, but of providing a dialogue leading to possible combinations of packages of alternative solutions with sensitivity to both the imperatives of the law as well as to concrete circumstances. Possible solutions can be modified, added or deleted during the testing process as one becomes more aware of the intricacies and the specificities of a given problem. On the other hand, responses from affected parties tend to alter over time as they, too, become more aware and better educated in the problem.

The flexibility of the assessment process becomes, then, the greatest attribute and vital element in the building of an implementation basis. While the laboratory scientists or the abstract theoretician might hesitate to identify the process as a test, the realistic testing against the perceptions of the field can produce insights as to the potential for long-range solutions which no rigid or preconceived experiment can provide. The. flexibility of this dynamic assessment process can also contribute to the productivity of the effort. In the most succinct form possible, the key argument here is that the heart of the problem rests with the institutional framework through which water is managed; and this framework is not immutable but can be changed from the endogenous and exogenous forces.

It is obvious, by now, that the continuous statements as to the iterative character or flexibility of this approach make it impossible to develop universal packages concerning implementing measures for irrigation return flow quality control. Indeed, the assessment process should not be designed to develop such packages. It could, however, be easily used for developing solution packages since the effort of implementation is in the process of describing the problem in its true characteristics and in the identification and assessment of potential solutions through an involvement of affected parties in a manner that tends to reinforce thinking in holistic rather than atomistic terms.

The process itself (of generating appropriate solutions and of testing for their eventual implementability) is the focus of attention and the central axis for providing “solutions” to problems of irrigation return flow quality. It is such a process that would link the problem, potential solutions and attainable strategies into definable means for implementing both the spirit and letter of P.L. 92-500 and of the broader social desire for a safe, productive and fulfilling environment.

THE ROLE OF CASE STUDIES

The approach and emphasis of the overall project, and of all case studies utilized as well, does not rest exclusively on the determination of “appropriate solutions” for the problem of return flow quality, although the last is a central point in communicating effectively the spirit of P.L. 92-500. The concern throughout begins with the process of <u>arriving at</u> appropriate solutions, in assessing in an interdisciplinary manner, and in outlining the steps for an eventual process of implementation of whatever may be the agreed-upon “solution” or program.

Thus, the study has been organized to provide for identification and analysis of the elements of an effective assessment of potential solutions and of building an implementation process concerned with the national goal of improved quality of this nation’s waters. To facilitate this approach, four areas have been selected in the western United States, within which the conceptual and methodological premises outlined previously could be applied.

In this manner, the problem that was identified and the techniques pursued would allow for a combination of theory and practice in order to develop specific recommendations for building a basis for implementing institutions and technologies for improvement of the quality of irrigation return flow.

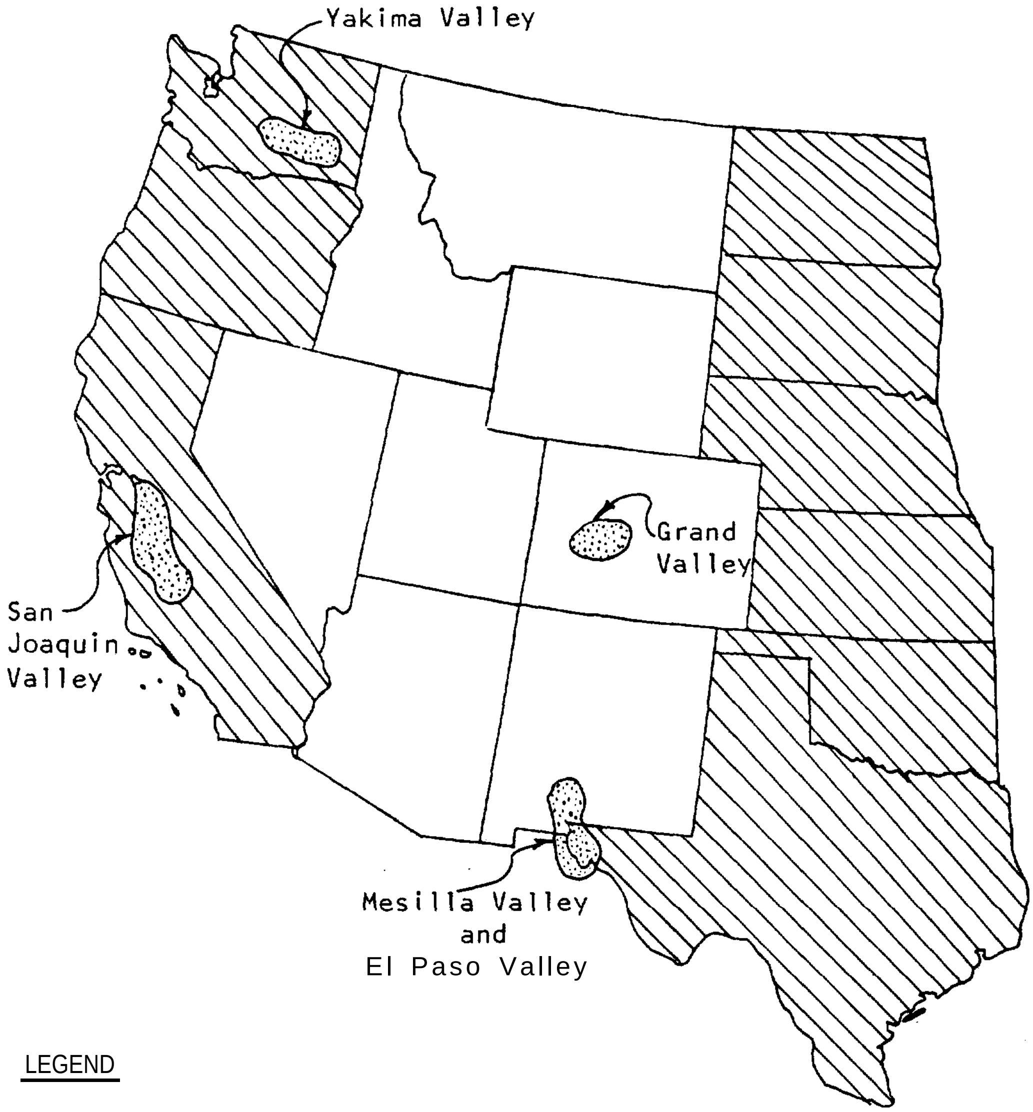
The selection of the areas of case study was guided by two criteria. First, considerable data collection and research had already taken place, or is presently underway, which will describe the problem situation; and, second, different problems of return flow quality would essentially make the study of institutions more meaningful and the description of potential implementation processes more sensitive to local conditions. The four study areas, as shown in Figure 9, are:

1. Yakima Valley, Washington.
2. Mesilla Valley, New Mexico and El Paso Valley, Texas (Middle Rio Grande Valley).
3. Grand Valley, Colorado.
4. San Joaquin Valley, California.

Yakima Valley is primarily noted for agricultural water quality problems resulting from sediments, phosphates and nematodes. Importation of additional water into the San Joaquin Valley as a result of the California State Water Project will yield additional drainage flows high in nitrates and salinity which will aggravate water pollution conditions in San Francisco Bay unless corrective measures are taken. Grand Valley is receiving considerable national attention because of high salt loads entering the Colorado River due to overirrigation. Finally, Mesilla Valley and El Paso Valley contribute salt loads to underlying ground water aquifers as well as the Rio Grande, with control measures becoming highly important with rapid urbanization in El Paso and Juarez (Republic of Mexico).

For three of the study areas, a special report was prepared which describes the physical, economic, legal, and social settings; irrigation return flow quality problems; technological and institutional solutions; and means for implementing these solutions. San Joaquin Valley, on the other hand, was used only as a background case, and no special report was prepared. However, some remarks as to implementation aspects derived from an analysis of this last valley have been incorporated into the main report. By preparing a report for each of the three study areas, considerable detail was provided which may be beneficial to locally interested parties, and which, at the same time, can serve as illustrative examples of the variety of problems related to irrigation return flow quality control.

The selection of the four sites represents not only the range of irrigation return flow problems, but also the variety of legal systems for water allocation and administration of surface and ground water intrastate and interstate. Within each system, various rights and obligations exist, and due to the hydraulic nature of water resources, the different systems are not always synchronous, therefore producing different problems.



LEGEND

Appropriations

Appropriations & Riparian Rights

Study Area

Figure 9. State water law systems and location of study areas.

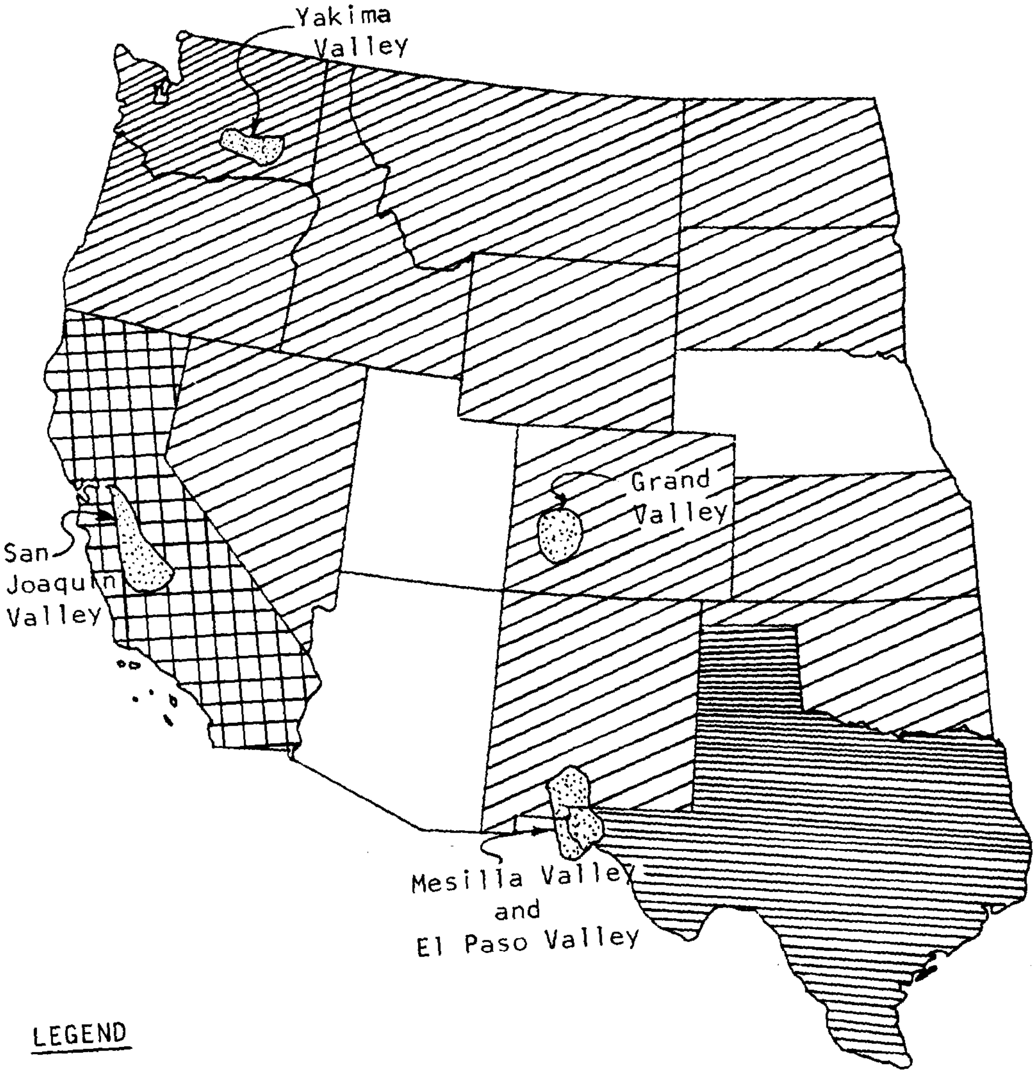
The surface waters within the western states are controlled by one of two systems: appropriation or combined appropriation and riparian system (see Figure 9). Colorado and New Mexico administer the appropriation doctrine with a variety of differences between the nature of the water right and the method of administration. California, Texas and Washington apply a mixture of appropriation and riparian law.

Ground water regulation among the selected areas is particularly relevant to defining institutional alternatives in irrigation return flow quality control (see Figure 10). Colorado, Washington and New Mexico apply the appropriation concept to subsurface withdrawal. California developed a unique concept of correlative rights in which reasonable use of ground waters is followed in normal recharge years, but proportional sharing is applied during periods of drought or excessive ground water depletion. Texas has continued to follow the common law absolute ownership doctrine, which allows unlimited withdrawal by the surface owner.

Superimposed over the state control systems are the interstate compacts and allocations and the federal claims to reserved waters. The Colorado River, which flows through the Grand Valley of western Colorado, has been apportioned by the Colorado River Compact of 1922 and the Upper Colorado River Basin Compact of 1948. The Rio Grande, which flows through Mesilla Valley and El Paso Valley, is controlled by the Rio Grande Compact of 1938, the Rio Grande Convention of 1906, Rio Grande Ratification Convention of 1933, and the Rio Grande, Colorado and Tijuana Treaty of 1944.

Due to energy developments in the western states and assertion of water rights in Indian Reservations and other federally withdrawn lands, the complexity of water real location in the various basins may be beyond comprehension. However, as a result of recent litigation in Colorado, the reservation doctrine is becoming more clearly defined and it may be possible to calculate the path to implementation of this doctrine as it will affect water quantity flows.

Finally, it should be pointed out that for each of these case studies, a different approach dominated the search for identifying and assessing potential solutions vis-a-vis irrigation return flow. In the case of the Yakima Valley, a questionnaire distributed to affected parties was developed and elaborated through a testing process along disciplinary lines, ending up as a synthesis through critical evaluation by the research team. In the case of the Middle Rio Grande Valley, while the solutions were defined by discipline, the questionnaire developed provided integrated solutions (rather than by the disciplinary approach characterizing the Yakima Valley). In Grand Valley, no particular questionnaire was used as in the previous two valleys, since the area has been currently experimenting with certain technological solutions. Thus, as far as technological solutions are concerned, only an evaluation was made, while institutional alternatives still remain to be examined. Again, in the case of San Joaquin, no separate study was prepared but only examples have been used throughout the main text in order to further accentuate types of problems and potential solutions related to irrigation return flow.



Appropriation

Common Law Riparian

Corrective Rights

Reasonable Use

Study Area

Figure 10. State ground water law systems in the western states.

In conclusion, the research approach proposed in this section attempts to link some general premises as to the process of implementing change, while at the same time narrowing, in the form of the categories suggested in Figure 8, the gap between the range of problems and the specific requirements for building the basis for implementation. The sections that follow are also consistent with the categories of Figure 8 as well as with the overall thrust of the argument that cumulatively and interactively builds throughout successive screening of problem description, identification and assessment of potential solutions, and concludes by outlining some characteristics of the process of implementation.

SECTION 5

NATURE OF THE PROBLEM

DETERMINATION OF THE CAUSES AND SIGNIFICANCE OF THE PROBLEM

Concern for the quality of our nation's waters is not a new problem. It is not possible to pinpoint the exact impetus that brought about the perception and definition of a water quality problem and which eventually led to specific organizing and representation in government. However obvious influences include: increased industrialization and urbanization, mounting evidence of environmental degradation, and the conspicuous failure of past abatement programs which were often "encumbered with vague or unenforceable authority (Rosenbaum, 1973). It seems reasonable to conclude that perception of the problem came most powerfully on the municipal and industrial levels; only as the problem became defined and the objective stated--to restore and maintain the integrity of the nation's waters--did it become clear that the problem of agricultural water pollution should also be addressed. Agricultural water pollution, then, was not the primary perceived problem, but became included in the policy process which involved polluting practices of a much broader scope. As a result, action by the government is focused on the whole problem of water degradation and on other specific problem areas, with few references directly to agriculture.

Water quality control has been a broad national objective since the enactment of P.L. 84-660, the Water Quality Act of 1956. From 1956 until the late 1960's, the emphasis has been almost entirely upon control of point sources of discharge from municipalities and industries. Obviously, these elements of pollution could be readily identified and various legal and economic measures could be designed to induce or compel elimination or reduction of harmful discharges.

The problems associated with pollution from agricultural uses of water are by nature much more diffuse and difficult to assess and control than those of point source introduction. By the mid-1960's, when salinity levels in the Colorado River began approaching plant tolerance levels in Mexico, there was widespread awareness of the problems associated with increased concentrations of salts in the lower Colorado River region and vocal demands for appropriate rehabilitation. Sedimentation, another nonpoint source pollutant, was beginning to attract attention in the Columbia River Basin. Other forms of chemical and suspended pollutants from agriculture were identified and their damage assessed in various localities all over the nation. Yet, response by state and local officials with regard to agricultural pollution control programs has been slow because of relative invisibility, localized nature of adverse effects and the earlier absence of a concerted program by the Federal Government.

Agricultural water quality control has long been part of a substantive discussion among the various basin states in the West. Problems ranging from salinity and chemical degradation, sedimentation and other problems associated with suspended material have been examined predominantly from the physical control perspective and technologies have been developed to alleviate or eliminate such problems. This preoccupation becomes particularly important if one bears in mind that the total land area in the fifty states is 916 million hectares (2,264 billion acres). While land use data vary from year to year on an average, one-half of this area is classified as "land in farms" and the remainder is "land not in farms." Urban America occupies about 25 million hectares, so almost 97 percent of the land is rural in nature. All of the rural land is a potential source of nonpoint pollution, as is a substantial fraction of the urban land area. The data here are impressive, especially if one is to point out that over 400 million acres (160 million hectares) are in cropland and deliver 2 billion tons of sediment annually to streams and lakes. This sediment includes a large but undefined amount of the approximately 440 million pounds (200 ki!ograms) of toxic pesticides used annually in agriculture. Animal wastes of livestock alone are estimated at about 2 billion tons, which is equivalent to ten times that produced by humans. As one begins to examine the total quantities of pollutants that are coming from nonpoint sources, especially in the rural areas, one can also appreciate the complexity of the problem that must be faced. It is obvious that increasing technology is not going to solve the nation's water quality problems. Indeed, more and more it is recognized that many of the gains made in the point source area will not bear fruit in terms of impaired water use because of the failure to act in the highly significant nonpoint source area.

Water quality control from irrigation return flows has caused one of the greatest degrees of disenchantment among state and federal personnel who are attempting to carry out water quality programs under P.L. 92-500. Since the time that the first regulations for irrigation return flows were initiated in 1973, there have been strong, conflicting differences of opinion among various agencies as to how to deal with water at both state and federal levels of government. More than anything else, many western states have called for a stop to their programs until EPA adopts what the states consider a workable approach. Not one western state has completely and enthusiastically embraced the program of including irrigation return flows as a "point source" and, thus, subjecting all irrigation to the NPDES program.

We should not attempt to describe here in detail either the agricultural sources of water pollution or to present in any detailed fashion all the problems involved with water quality policies. Three particular areas of concern must direct the argument. The first has to do with the legal imperatives as expressed in the mandates of P.L. 92-500. The second has to do with a broad outline of the physical dimensions of the problem. And, the last would relate our concern with the organizational preparedness in meeting the problem, particularly in developing the context for planning, decision-making and for building the basis for implementation.

The Legal Background

Formulation and Legitimation--

The efforts of the sponsoring Congressmen and both House and Senate committees were devoted to producing a powerful, decisive piece of legislation which would drastically reduce pollution of our nation's waters. Therefore, Section 301 (a) requires that, except under conditions outlined in subsequent sections, the discharge of any pollutant by any person shall be unlawful. During debate in the House of Representatives on its version of the bill, H.R. 11896, Teno Roncalio, Representative from Wyoming, offered an amendment exempting return flows from agricultural irrigation (A Legislative History..., 1972: 651). He argued that this amendment was important to the credibility of the legislation, since the technology for identifying and specifically tracing irrigation pollutants did not exist and, therefore, the bill would be unenforceable in the case of agriculture. Comment was expressed in favor of the amendment until the representative from California called attention to the San Luis Drain which dumps highly polluted irrigation return flows into the San Joaquin River in California. That single case seemed to sway the opinion, in spite of the thousands of agricultural users whose impact would be much less significant, and the amendment was defeated (Ibid., p. 6528).

Section 402 of the Act created a National Pollutant Discharge Elimination System (NPDES), by which permits could be issued to allow discharge of pollutants under specified conditions. By not excluding irrigated agriculture from the provisions of Section 301, it became subject to the permit program. The ramifications of the failure to pass his amendment have been clearly outlined by Mr. Roncalio when he stated (Ibid., p. 860-861):

> Moreover, the technology to control salinity resulting from irrigation use is not available. There is no feasible method of treating irrigation wastes in those cases when irrigation discharges can be isolated from natural sources of runoff. Usually it is impossible to locate a particular discharge and match it to the proper irrigator before it percolates into a ground water reservoir, or returns to the original stream.
>
> The most insurmountable difficulties encountered, however, could be the administrative problems. The number of federal applications for all irrigation discharges would be staggering. In Wyoming alone, between 35,000 and 40,000 permits would be required. When applying for a federal discharge permit the burden of proof would be on the water user to show that the environment would not be harmed. For those who were not granted a permit, valuable property rights would be lost without compensation, and this involves serious implications for the courts.
>
> Moreover, the massive bureaucracy needed to process the permit applications would have uncertain jurisdiction. Would it have to completely supercede functioning state water right mechanisms in order to operate effectively? If so, the prior appropriation doctrine would be reduced to an unrecognizable shambles. This

> could cause disastrous instability throughout the West among current water right holders. The effect on investment incentives and property values is incalculable. At best, a phenomenal paper work logjam could be created with negligible improvement in water quality.
>
> Even though effluent control may be chosen as the best method of controlling pollution contributed by industrial and municipal wastes, it does not appear at present to be a practical method of controlling nonpoint sources of salinity associated with irrigation.

The fact that the San Luis Drain case so closely resembled the point source kind of pollution with which legislators from most parts of the nation are familiar may account for its powerful influence in their vote against Roncalio's amendment.

In Senate debate, Mr. Dole, Senator from Kansas, pointed out the fact that agricultural pollution is generally a nonpoint source. An exchange between Senator Dole and Senator Muskie, one of the primary sponsors of the bill, is informative (Ibid., p. 1298-1299):

> Mr. Dole: Another question of real concern to many farmers, stockmen and others in agriculture involves the terms 'point source' and 'nonpoint source.'
>
> Most sources of agricultural pollution are generally considered to be nonpoint sources.
>
> My question is: Simply, to what sources of guidance are we to look for further clarification of the terms 'point source' and 'nonpoint source'--especially as related to agriculture?
>
> Mr. Muskie: Guidance with respect to the identification of 'point sources' and 'nonpoint sources,' especially as related to agriculture, will be provided in regulations and guidelines of the Administrator.

This indicates that it would be EPA's responsibility to clarify the terms "point" and "nonpoint" source and thereby to determine applicability of Section 402 permit requirements. Thus, the legislature defeated the proposal to exclude agricultural pollution and passed the problem on to the Administrator of EPA.

Administration and Application--

On December 22, 1972, regulations were promulgated and published in the Federal Register (40 FR 54182) establishing guidelines for State Program Elements Necessary for Participation in the National Pollutant Discharge Elimination System (NPDES) (37 FR 28290). Comments received in response to these regulations and to proposed NPDES application forms indicated a need to consider the desirability of attempting to extend the permit system to all point sources conceivably covered by the broad definitional framework established by the Federal Water Pollution Control Act. EPA's intent to consider: 1) further comments with respect to the NPDES application form for agricultural discharges, Short Form B; and 2) exclusions from the permit system, particularly for agricultural and silvicultural sources, was indicated in the Federal Register on December 29, 1972 (37 FR 28765).

On May 3, 1973, EPA proposed a revised Short Form B for agricultural discharges and proposed classes and categories of silvicultural and agricultural activities which would not be subject to NPDES permit requirements (38 FR 10960). On May 22, 1973, regulations establishing policies and procedures for issuance of NPDES permits by the Federal Government were promulgated and published (38 FR 13528). In that publication, Section 125.4 entitled Exclusions, provided that NPDES permits were not required for discharges from separate storm sewers composed entirely of storm runoff uncontamined by industrial or commercial activity. Subsequently, on July 5, 1973, after receiving information, statistics and advice from other federal agencies, state officials and agricultural groups in response to the May 3, 1973 proposal, EPA issued notice of the availability of the final agricultural application Short Form B and published an amendment to Section 125.4 (38 FR 18000). This amendment provided for an expansion of the exclusions in that section, eliminating categories of small concentrated animals feeding operations and certain agricultural and silvicultural activities from the permit requirement. Specifically, irrigation return flow from sources of less than 3,000 acres was exempted. The EPA Regional Administrator or the Director of a state water pollution control agency could override the exclusions by identifying individual sources as significant contributors of pollution. Once so identified, significant contributors of pollution were required to apply for and comply with NPDES permits (40 CFR 124.11 h(5)).

In promulgating the July 5 regulations, EPA stated its belief that while some point sources within the excluded categories may be significant contributors of pollution which should be regulated consistent with the purposes of the FWPCA, it would be administratively difficult if not impossible, given federal and state resource levels, to issue individual permits to all such point sources. In addition, the agency stated that regulation through the use of site-specific NPDES permits was not appropriate for most of the small sources covered by the exemption. Essentially, these regulations providing for exemptions were based upon EPA's view (a view which it continues to maintain is correct) that most sources within the exempted categories present runoff-related problems not susceptible to the conventional NPDES permit program, including effluent limitations. EPA's position was and continues to be that most rainfall runoff is more properly regulated under Section 208 of the FWPCA, whether or not the rainfall happens to collect before flowing into navigable waters. Agricultural runoff frequently flows into ditches or is collected in pipes before discharging to a stream. EPA contended that most of these sources are nonpoint in nature and should not be covered by the NPDES permit program. EPA felt that this was an exercise of limited administrative discretion in excluding these basically nonpoint sources from the permit program and the best means for achieving the Congressional intent consistent with the language of the FWPCA.

Reaction and Evaluation--

Quite naturally, farmers with more than 3,000 acres of land objected to the regulations. In Idaho, where the state agency attempted to administer a permit program, farmers joined together to fight the system in court. They argued that the 3,000-acre limitation was only arbitrarily chosen without direct relationship to pollution contribution. Officials in the Department of Ecology in the State of Washington watched Idaho's experience and decided to implement a much less objectionable (but, entirely ineffective) program of issuing permits on waste water only (excess water which had not been applied to the fields, but was wasted back into the waterway). This seems to be a clear indication of the infeasibility of implementing the NPDES program as it was outlined in the administrative regulations.

Another attack on the regulations issued by EPA came from the environmental front. The Natural Resources Defense Council (NRDC) challenged the exercise of the Administrator's discretion in exempting certain sources of pollution from the NPDES permit program. In a law suit filed in the Federal District Court for the District of Columbia, NRDC contended that the Administrator had failed to meet the legislatively implied obligation to delineate, by regulation or otherwise, between point and nonpoint sources and had instead simply exempted portions of what remained classified as point sources. The very inclusion of some sources of irrigation return flow (areas over 3,000 acres) in the NPDES program is taken to be an implied classification of these sources as point sources.

Defendants Train and EPA contended that the exempted categories of sources are ones which fall within the definition of point source but which are ill-suited for inclusion in a permit program. Pollutants, EPA maintained, are best eliminated from agricultural discharges by "process changes" which prevent pollutants from entering runoff rather than by treating the discharge by the "end-of-pipe" method. EPA argued that the Act and its legislative history reflect congressional recognition that such runoff is to be dealt with in a nonpoint method. Moreover, it was EPA's contention that the tremendous number of sources within the exempted categories would make the permit program unworkable. Faced with this problem the Administrator harmonized the conflicting demands for regulation of point sources by exercising his discretion under the permit program to establish the challenged exemptions (see 7 ERC 1881).

The District Court ruled in favor of NRDC and on June 10, 1975 issued a final order requiring EPA to propose and promulgate regulations "extending the NPDES permit system to include all point sources" in the concentrated animal feeding operation, separate storm sewer, agricultural and silvicultural categories. Under the terms of the order, EPA was to propose regulations extending the permit system to point source discharges in the agricultural and silviculture categories by February 10, 1976.

As part of the effort to carry out the requirements of the court order, EPA solicited and received information, statistics and advice from other federal agencies, state and local officials, trade associations, agricultural, silvicultural and environmental groups and interested members of the public. Public meetings were held across the country; those in Denver, Portland

(Oregon), Indianapolis, and Atlanta specifically considered the agriculture and silviculture categories. At each of these meetings, persons representing both potential permittees and permit issuing agencies voiced significant opposition to the development of an expanded permit system within the NPDES program as it had been administered to date. Many commenters pointed out that such a program would require a massive commitment of resources, both by the dischargers and by the issuing agencies, which would not be commensurate with the modest pollution reduction gained from the program. They also emphasized that numerical effluent limitations are inappropriate for pollution abatement from most of these point sources, and they urged EPA to consider alternative pollution control processes and methods as a basis for any proposed permit system. Finally, several commenters strongly recommended that EPA reconsider the explicit legislative history of the FWPCA concerning agricultural nonpoint sources and adapt the proposed regulations to the language from that history. In general, most participants strongly recommended that EPA develop factors to distinguish point sources from nonpoint sources, and suggested specific criteria to designate most discharges from agricultural activities as nonpoint in nature and thus not subject to the permit program.

Resolution and Change--

Taking these comments, as well as the legislative history, the statutory language, the NRDC vs Train decision, and the technical data available on agricultural activities into consideration, EPA examined the relationship between the NPDES permit program (which is designed to control and eliminate discharges of pollutants from discrete point sources) and water pollution from agricultural activities. On February 23, 1976, EPA proposed a new program for dealing with agricultural activities.

The new regulations stated that water pollution from most agricultural activities is considered nonpoint in nature and thus not subject to any permit requirements. However, discharges of pollutants into navigable waters through discrete conveyances, which result from the controlled application of water, are considered agricultural activity point sources. A new section, 124.84, was added to the regulations to set forth the distinction between point and nonpoint sources.

Agricultural activities, particularly irrigation, which result in surface discharges: 1) which contain pollutants; and 2) which result from the controlled application of water by any person, and which are not caused or initiated solely by natural processes as precipitation; and 3) which are discharged from a discernible, confined and discrete conveyance; and 4) which are directly discharged into navigable waters; are subject to regulation under Section 402, the NPDES permit program (41 FR 7964).

It is clear that this definition would apply primarily to irrigation return flow ditches. Although these ditches are considered point sources, in most cases there are no conventional permit requirements at this time. Because of the lack of pollution control technology, discharges of agricultural wastes from agricultural activity point sources are proposed to be permitted by general permit(s). The procedures for issuance of the general permit(s) will be proposed simultaneously with the promulgation of these regulations. Unless required by the director of a state water pollution control agency or by the EPA Regional Administrator under special circumstances, no owners or operators of agricultural point sources are required to apply for or obtain individual pollution discharge permits. It is expected that the director or Regional Administrator will impose individual permit requirements on owners and operators only in exceptional cases.

EPA has gone one policy cycle thus far and has established a clear-cut administrative regulation defining agricultural point sources. There still remains the question of how the general permits, which are required, will actually be handled. It is likely that their administration will elicit reaction from affected parties which may bring further changes. One reaction to the proposed regulations is already brewing in the western states. Many in this part of the country contend that the regulations are discriminatory against farmers who cannot rely on natural precipitation and must use controlled application of water to produce crops, but may not necessarily cause more pollution than nonirrigation farmers. Such a protest has been registered by the Colorado River Water Conservation District which argues that Congress never intended to treat agricultural activities involving irrigation runoff and return flow as point source pollution (see 7 ERC 1881, Note 4).

One thing is clear: the end is not yet in sight. Considerable discussion, reaction, debate, administrative adjustment, litigation, and legislative action are likely to take place before the issues of the FWPCA, as it applies to agriculture, are fully resolved.

Generalizing the Problem of Agricultural Pollution

There are many ways of approaching the problem of potential pollutants from agricultural cropland. Essentially, there are two primary mechanisms for pollution by irrigated agriculture: 1) direct runoff of applied surface water; and 2) artificial drainage of irrigation water which has seeped below the root zone of irrigated crops. In a descriptive fashion, we can see the potential degradation of water quality through water, land and chemical use in the descriptive categories of Figure 11. In this scheme, the principal pollutants associated with direct surface runoff include sediment, phosphates and pesticides (as well as crop residues and bacteria). Pollutants associated with artificial drainage are dissolved solids (salinity) and nitrates.

In physical terms, the mechanisms for pollutant loading as well as the effects of pollutants associated with irrigated agriculture have been observed in a variety of studies. However, the quantification of the causal relationship between agriculturally derived waste loads and impaired water quality is very difficult to define since the following factors are crucial in such a determination: a) the complexity of the waste loading processes; b) the large number of highly localized conditions affecting waste load generation; and c) the contribution of the same type of pollutants from other sources, natural and man-induced, which cannot be quantified in the literature at this time.

It is interesting to notice that most of the categories described above have been also referred to in the literature as <u>point source</u> contributors

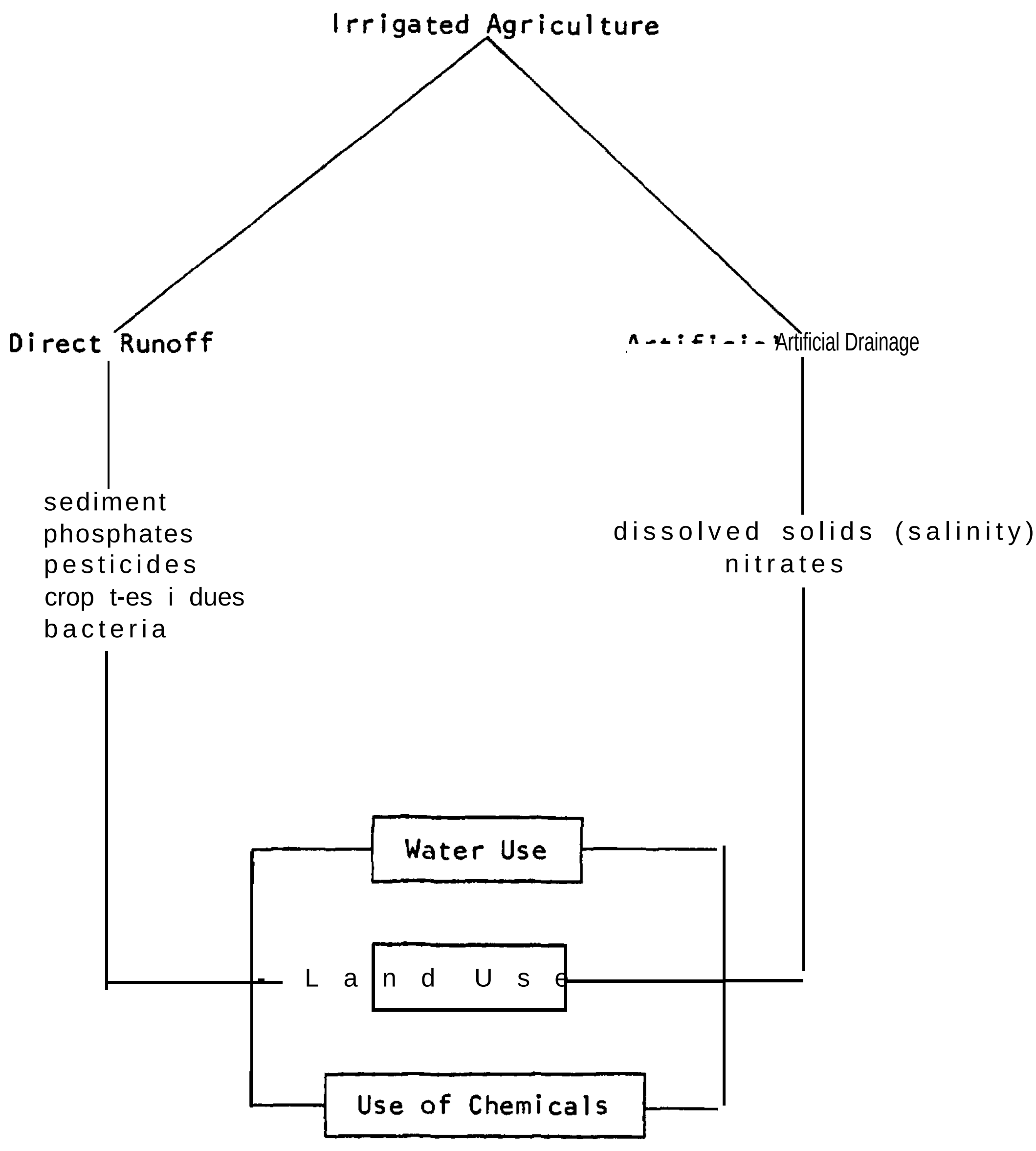


Figure 11. Potential cause of water quality degradation.

since the dividing line between them and the nonpoint pollution is the extent to which pollutants are discharged by man-made conveyance. The distinction between point and nonpoint pollution is not only one of high methodological importance, but also one that centrally determines the political ramifications of controlling degradation of water quality from agricultural sources.

As outlined previously in the discussion of the legal background, the major vehicle for insuring that point sources comply with the effluent limitations established by EPA pursuant to Section 301 and 304 is Section 402 of the Act which establishes the National Pollutant Discharge and Elimination System (NPDES). The issuing of permits for the discharge of any pollutants establishes the conditions under which the term “discharge of a pollutant” may be traced to any discernible, well-defined and traceable conveyance from which pollutants are or may be discharged.

It would be torturous to further elaborate what ensuing legal and interpretive arguments have brought about. It is obvious, however, that both the interpretation of the law as well as prevailing practices confirm the statements made during the hearings concerning the complexity of the water pollution control legislation. As it was stated then, by Senator Muskie, no bill consumed so much time, demanded so much attention to detail, and required such arduous efforts to reach final agreement as did the 1972 Act. The Act, a document of more than 89 pages of fine print, is indeed one of the most complicated pieces of legislation ever to emerge from the Congress, and it appears that it has not been completely understood by some of the legislators and by some of those charged with implementing the legislation. If nothing else, there has been and there is still strong disagreement between the authors of the Act, EPA officials, as well as users at the end of the line, over many of the key provisions of the Act and over the general water pollution control strategy to be followed, especially in western states.

The important argument for us is that the Act set into motion a set of conditions and an argument that is still being debated in the field and whose interpretation provides many of the difficulties in efforts to implement what many people consider impossible standards and criteria. Questions out in the field have to do with the extent to which the various water quality standards will be characterized by cooperation and negotiation between government levels; the persons who will participate in such activities; the establishment of management practices; the actions necessary to implement the particular requirements; etc.

Forging this new national program for water quality was not a simple act-- of interpretation and enforcement. Since it has been under development for over five years, a diversity of opinions on the goals and the complexity of achieving water quality has created rather polarized opinions as to the differences between the arid West and the humid East; as to the conflicting and competing purposes of industry and agriculture; as to local versus regional or national interests; and, as to the variety of myriads of technical, economic, political, and social factors affecting the letter and spirit of the particular legislation.

Perhaps the most important point in the interpretation of the law has been the universal recognition that basing compliance and enforcement efforts on a case-by-case judgment of a particular facility or area of impact on the existing water quality is both scientifically and administratively difficult. At the same time, to try to bring together the variety of local conditions and the particularities involved in the invisible and difficult-to-track-down categories of agricultural pollution have also generated an argument, compounded by existing socio-cultural practices in the arid West; the legal limits as to beneficial use of water; and, generally, by the precarious character of protecting rights highly dependent on varying physical conditions (in particular the influence of the current drought in the West and how the argument is interpreted and reinterpreted as to the priorities of maintaining productivity under adverse ecological conditions).

Yet, the heart of this water quality program remains a permit system which establishes a distinct new pattern of federal-state relations in water quality management. This program, which was established by the President in 1970 under the Refuse Act of 1899, was initiated as a means to accelerate and strengthen clean-up efforts pending new legislation. The permit mechanism had the virtue of establishing for the first time a comprehensive information-gathering system especially for industrial effluents. At the same time, it provided for each discharging facility a specific treatment and timetable to eliminate haggling and uncertainties between government and industries.

Noble, useful and far-reaching as this provision may have been, the jumping from the point, well-defined pollution of industry and the permit system that characterize such an approach to the particularities of agricultural pollution and, therefore, the tracking down of “nonpoint sources” of pollution required a very difficult methodological and administrative determination as to what is “point” and what is “nonpoint” pollution, the elaboration of the physical dimensions of the problem, and the agonizing, slow process of acceptance and enforcement.

It may have been unfortunate, but the permeating spirit of the NPDES program has created hard feelings between those who insist on the permit program as a major attack of providing both information and the means for producing the biggest payoff in water quality and for which implementation is feasible now; and those who believe that nonpoint sources, such as farmland runoff of soil and fertilizer, are impossible to track down, and that a permit system is essentially uneconomical and in the long run counterproductive to the efforts of agricultural efficiency. This situation was further made difficult by the Natural Resources Defense Council v. Train decision, which in effect forced EPA to issue effluent guidelines for each of the previously excluded sources, defining treatment necessary by 1977 and 1983. If discharge permits will have to be issued, given the existing lag in effluent guideline development and the hard feelings generated by this particular approach, significant administrative problems are posed that affect implementation efforts.

In conformance with the 1975 decision, EPA has modified its definition of point sources, but still attempts to exclude the smallest activities.

The dilemma here becomes rather obvious. Given the fact that a number of studies have already pointed out that regulation of point source discharges alone will not improve water quality enough to meet the general national water quality goals, increased urgency permeates a desired comprehensive program for removing pollutant loadings from natural sources, unregulated agricultural activities, urban stormwater runoff, and other nonpoint sources. To deal with nonpoint source pollution, EPA plans to rely upon the regional comprehensive planning required by Section 208 of the Federal Water Pollution Control Act. However, no additional Section 208 planning agencies have been funded since July 1, 1975. So, at this time it is not clear whether the agencies given this planning responsibility have either the necessary authority or access to adequate financial and technical resources to cope with a nonpoint source problem.

It is apparent by now that the nonpoint sources of pollution loom as an omnipresent background issue over many of the current state water quality programs. Since there is a pervasive feeling that pollutants that are not discharged from identifiable or discrete outflows are often considered outside the scope of the state control efforts, there is little regulatory attention directed towards this enormous quantity of pollutant material which reaches the nation’s streams through runoff, drainage from mines and other excavations, and return flows from irrigation. In essence, the law has established a general spirit and approach that conforms with the popular demand for controlling pollution from all sources (point and nonpoint). However, the exploration of the character and distribution of major nonpoint sources requires a better understanding of their potential pollution and of what can be done. The task is compounded by the inability to track down exact baseline conditions; and by difficulties in developing a spirit of cooperation and negotiation between the Federal Government, state authorities, and, finally, the ultimate water users.

By now the point of the above discussion should be obvious: if people do not agree as to the nature of the problem, the wisdom of certain provisions of the Act, and as to the feasibility of proposed solutions, then implementation becomes impossible and a fertile climate of dissention and cross-purpose negates the achievement of collective goals. However, our approach in the present study was not to assume that NPDES would be our guiding star. Instead, as an interdisciplinary team we began by juxtaposing alternatives and strategies, by obtaining local responses as to solutions to irrigation return flow control problems, and by attempting to synthesize what is technically feasible, legally appropriate and socio-economically implementable. While the background spirit of P.L. 92-500 looms in all our discussions, the approach followed began from specific problems, backtracked to appropriate strategies, and, finally, considered the institutional arrangements and rearrangements for meeting the quest of implementing policies for controlling irrigation return flow.

PARAMETERS OF INVESTIGATION

The discussion of the parameters of the irrigation return flow quality problem revolves around an identification of the particular causes of the problem in order to establish a basis for identifying potential solutions. The brief remarks that follow in this section outline legal conditions and management practices; physical dimensions; and, socio-economic considerations.

Much of the focus in irrigated agriculture has been to expand existing irrigation systems by increasing the water supply, rather than improving the use efficiency of existing water supplies to more effectively produce crops and reduce the quantity of return flows. Farmers generally perceive the solutions to water problems as revolving around more water supply; indeed, many of the existing institutional mechanisms for assisting irrigated areas facilitate this approach. As a consequence, many irrigated areas are overirrigated which results in large quantities of iirigation return flows. In many cases these return flows result in significant water quality degradation. In such cases, there is a direct relation between the inefficient use of water and the resulting water pollution. Alleviating water quality degradation from irrigated agriculture will, in most cases, require increasing the efficiency of water use, which involves improving water management practices.

In improving water management practices, there exist a number of institutionalized constraints which make the actual acceptance of proposed practices difficult. Such practices require that irrigation return flow quality control include both dimensions of the resource problem--water quantity and water quality. Separate categories of laws have evolved for each dimension, each taking on characteristics which contribute to the problem and compound efforts to improve the quality of return flows. These practices must employ a program that would incorporate cooperation between organizational entities and the individual user, something which is not now present. It is these constraints that constitute a major part of the problem at hand.

Problems of irrigation return flow quality are compounded by the specific perceptions of individual farmers regarding pollution and the geographic significance of the problem. Farmers know that using irrigation water will cause some degradation, but the point at which it becomes significantly detrimental and who is responsible are a major source of contention. Many farmers either do not perceive the consequences of their action or they believe that with the existing means of irrigating (which are the correct means), the level of pollution is natural and, therefore, acceptable. There is also the lack of a broader perception involving the regional nature of the problem, since farmers are mainly concerned about their own property. The critical point is that a water user’s perception of the farming situation and the problem of water quality in particular dictates how that person will accept any innovative technology to solve a given “problem.”

The above discussion relates some of the difficulties in gaining popular support for the necessity to alleviate water quality degradation from irrigated agriculture. The heart of the matter and a major cause of the problem is the use of too much water; thus, a central constraint to improving water use efficiency in the West is the present system of water law administration. Water is allocated, distributed and administered under a body of law which grants to the user a water right synonymous to the property right interest one can acquire to land. The water right is not one of absolute ownership, but rather one for the use of water only and subject to specific conditions and concepts which theoretically are prescribed to protect the public and other users.

Until the past few decades, water used for irrigation was not considered a type of use that required strict application and enforcement of the law to achieve water quality goals. In fact, many of the concepts and conditions provided guidelines for allocation and distribution with implementation carried out when the water right was granted and thereafter only when severe abuse occurred or another user complained.

The primary elements of the water quantity law which contribute to both the problem of degraded return flows and efforts to improve the quality are:

*Failure to enforce legal conditions for water use, namely, beneficial use and nonwaste.

*Constraints in the law which prevent the transfer of excess and saved water to other lands or users where it could more effectively be used.

*Lack of adequate recognition of the legal duty to include water quality control as an attribute of the water right to be enforced particularly by irrigated districts.

*Restrictions or deficiency in the law on the use of low-cost funding from state/federal programs for water quality control.

These four factors provide the explanation for water user conduct as well as constraints to adoption of more efficient physical and technical solutions that may not only improve the quality of return flows, but also increase crop production.

The doctrine of prior appropriation has led water users into a continual diversion of their full “water right” for fear of loss of this right if the full amount were not used. Therefore, users have been unwilling to sell, rent or lease any portion of their water right, which could have lead to economic benefits to both parties, as well as more efficient use of the resource. There has been no market for reallocating irrigation water. Farmers have also been able to pass on to downstream water users part of the costs of production in the form of pollution.

The present institutional arrangement allocates water on the basis of a priority of rights rather than on the value of use. The price of water is generally the cost of its conveyance to the farm and does not represent the value of opportunities foregone. The result is that the use of water is not competitive; it is not allocated to its highest valued use; and its relatively low price causes it to be excessively applied.

With the exception of irrigation water, farm inputs are allocated through markets. Labor and capital, for example, are allocated and priced through markets according to the value of their use. Consequently, water tends to be relatively cheap, so that profit-maximizing farmers rationally substitute water for capital and labor (i.e., water management) in the production process. The result is an over application of water with associated return flow pollution. Irrigation return flow pollution also results from the avoidance by farmers of some costs of production. The profit-maximizing farmer attempts to minimize production costs. In so doing, he may select production methods and techniques which are low cost to him, but polluting to downstream water users. Alternative production methods and techniques may be less polluting but of higher cost to the farmer. By selecting the lowest cost methods and techniques, the farmer passes on part of the costs of production to downstream water users in the form of water pollution.

Irrigated agriculture is a collective enterprise involving all of the users. Improving, existing water management practices, whether to alleviate water quality degradation or more effectively utilize existing water supplies to increase crop production, certainly requires collective action. There exist a number of organizational entities that administer irrigation, but, generally, there is a lack of explicit rules established for the management of this resource with regard to quality. There also exists a lack of communication and coordination between agencies and districts, and the farmers with regard to how the water should be managed. As a consequence of the lack of an explicit institutional framework surrounding this problem and certain individual perceptions that do not enhance a specific water quality management ethos, implementing a program of irrigation return flow quality management can be expected to be a very difficult task, further complicated by the economic and legal conditions outlined above.

Finally, in the context of the case studies, the approach for implementing feasible irrigation return flow water quality policies recognizes that each area has its own unique feature. A thorough understanding of the physical dimensions of the problem and its effects is required in each case. Problems which may appear similar on first appraisal will generally show quite distinct differences on deeper investigation.

The four areas investigated in this study to illustrate the variety of problems that exist and the diverse approaches to the solutions of those problems represent a continuum of circumstances. Grand Valley, San Joaquin and the Middle Rio Grande Valleys are recognized as having “salinity problems,” but the nature of those problems are quite different. In the Grand Valley, irrigation of the soils overlying the saline Mancos Shale has caused a rise in the water table with subsequent salination of the soil and reduced production from lower-lying lands in the Valley. However, the problem is not confined to the Valley alone, as saline water in contact with the shale is displaced into the river by incoming water from deep percolation and seepage. Each year approximately 700,000 tons of salt (or 10-12 tons per irrigated acre) are added to the river as it passes through the Valley, adding to the burden of downstream water users.

In the San Joaquin Basin, the problem has a different nature in each of the two physiographic areas. In the Tulare Lake Basin, which now has no outflow, salt accumulates in the soil and ground water of the basin to the detriment of agricultural production and ground water quality. In the San Joaquin Valley to the north, the concentrating effect of irrigation is making the water unsuitable for downstream users, and is causing a deterioration in ground water quality and subsurface return flows.

The Middle Rio Grande Valley is faced with the two-sided problem of an increase in the concentration of salts in the river with distance down the Valley, coupled with an increase in soil salinity. Although the salt concentration is increasing because of the concentrating effect of irrigation, the salt load is decreasing as salts applied in the irrigation water are being retained in the soils and ground water. Not only is the river suffering, but the land, particularly in the lower Valley, is suffering due to soil salination, with a consequent depression in crop yields and a move to lower valued crops.

The Yakima River suffers from high levels of nitrates, phosphates, sediment, temperature, and coliforms--all associated with agricultural activity. Apart from aesthetic objections to the algal growth and sediment, and the significant deterioration in the fish habitat, economic costs are incurred in irrigation intake screen cleaning, sediment removal from hydraulic structures, the wear on pumps, sprinkler heads and pipes, and in the reduction of productivity associated with topsoil and fertilizer losses. The selection of the four sites for an articulation of our approach represent not only a range of irrigation flow problems, but also a combination of legal systems for water allocation and administration of surface and ground waters intrastate and interstate; a variety of socio-economic conditions; and, a spectrum of cultural practices.

SECTION 6

IDENTIFICATION OF POTENTIAL SOLUTIONS

THE PROCESS OF IDENTIFYING SOLUTIONS

The basic premises of the process for identifying solutions have been outlined in Section 4. There, it was indicated that the search for "feasible" solutions requires an integration of the provisions of the law with the recipients' desires through appropriate institutional linkages. Through a combination of a review of literature (based on disciplinary search), site visits and interdisciplinary exchange, the team assembled an initial list of "solutions" concerning irrigation return flow quality control. The search for "appropriate" solutions was, then, part of a screening that considered such factors as (see also Figure 4 and 6): a) technical soundness; b) economic viability; c) legal pertinence; d) social acceptability; and d) political feasibility.

It should also be recalled that in arriving at appropriate solutions, the team has also previously outlined critical parameters of the problem; explicated the provisions of the law; and, determined responsible organizations, affected individuals and related agencies. In addition to the project team, further sensitivity was obtained through interaction with state and federal agency personnel; irrigation water management; and water users.

The initial selection of solutions along the characteristics suggested in Figure 4 allowed for an initial elimination of nonappropriate or ill-advised solutions. Eventually, an iterative process of assessment and evaluation provided the team with alternative solutions which range from those which are wholly technical to those which are purely institutional (e.g., creation of water markets). This very process of generating (and assessing and evaluating) solutions becomes the vital link between the problem of agricultural pollution and of attainable strategies for implementing P. L. 92-500.

TYPES AND RANGE OF PROPOSED SOLUTIONS

The range of possible solutions to irrigation return flow pollution is, of course, a function of the parameters of the problem identified in the previous section. Potential solutions are discussed in this section in terms of the causes of the problem.

There are a number of potential solutions for controlling the quantity and quality of irrigation return flow. The irrigation system may be subdivided into the water delivery subsystem, the farm subsystem, and the water removal subsystem. The use of efficient practices in the conveyance canals and pipelines, as well as improving on-farm water management, will minimize the problems in the water removal system. In most cases, the key to minimizing irrigation return flow quality problems is to improve water management practices on the croplands. The water delivery subsystem can be improved by lining canals and laterals, using closed conduits for water transportation, providing adequate control structures, and installing flow measuring devices.

Improved practices that can be used on the farm include judicious use and application or placement of fertilizers; use of slow-release fertilizers; controlling water deliveries across the farm; use of improved irrigation application methods (e.g., subsurface application, sprinkler irrigation, or trickle irrigation); control of soil evaporation; use of a pumpback system to allow recycling of surface return flows; erosion control practices (e.g., contour farming) ; and irrigation scheduling to insure that the proper amounts of water are applied at the times required by the plants. In the water removal subsystem, open drains and tile drainage can be used to collect return flows, which can then be subjected to treatment on a large area or basinwide basis, if necessary.

Identifying appropriate technological solutions must be related to the nature of the problem, i.e., water quality degradation as a result of surface or subsurface return flows, or both. Knowing the sources of pollution, then potential solutions can be identified. The appropriateness of such solutions will be related to other "site specific" physical parameters, as well as historical irrigation methods and practices in the area, and the perception of the users regarding the necessity for change. In addition to informing the water users of the existing irrigation return flow problems, it becomes necessary to demonstrate appropriate technologies in order to gain farmer acceptance. This phase, as well as areawide implementation, could easily be hampered by the lack of sufficient technological assistance and by the legal constraints on the use of low-cost government funding to achieve water qua!ity improvements at the farm level. improved irrigation water management practices will almost invariably result in reduced demand for water diversions. The real difficulty in gaining water user acceptance lies in solving the problem of who benefits from the saved water. At the present time, the irrigator cannot benefit from the water saved by improved irrigation water management practices. Consequently, little progress in water quality control of irrigation return flows can be expected until the water right issue is addressed.

One of the viable alternatives for producing a positive incentive for water users to benefit from improving their irrigation system is to establish a market for irrigation water. In order to minimize the disruption of the present institutional arrangement, the market form identified as having the greatest potential is a water rental market. The demand for rental water would represent its addition to the total value of output per additional unit of water. The market supply schedule would represent the water right holder's increasing opportunity cost of using the water himself rather than renting it. The market equilibrium price would be greater than the current costs of conveyance. Those demanding and supplying would have an economic incentive to use water more efficiently. That is, a rental market would increase the price of water to its marginal value in production and would encourage more use of labor and capital (Le., water management) in combination with the water, thus reducing return flow pollution.

Such an arrangement would take into account the present structure of water rights and allotments. Those with water rights or allotments, however, would be allowed to rent surplus water to other users without jeopardizing their rights or allotments in the future. In most states, such a market could be created by removing the legal and physical uncertainties associated with such transfers under the present system. Transfers within irrigation districts of excess or saved waters require changes in both Federal Reclamation and some state laws.

With regard to economic solutions, further discussion is needed to illustrate this particular disciplinary input. Water utilized for irrigation can be conceptualized as passing through three phases: diversion, application and discharge, as shown in Figure 12. The water is diverted from a stream, applied to crops and that portion not consumptively used returns to the stream. Irrigation return flow quality is a function of the water's travels from diversion to discharge. The amount of pollution resulting from the irrigation process obviously depends upon a large array of variables, such as soil type, slope of field, type of crop, stage of crop growth, irrigation management, and quantity of water applied. The present discussion focuses on the managemen t and quantity of irrigation water as the most critical variables.

In general, the amount of return flow pollution is positively correlated with the quantity of irrigation water and negatively correlated with the management of irrigation water, as shown in Figure 13(a) As water is applied beyond the consumptive use requirements of the crop (c.u.), return flow pollution tends to increase at an increasing rate with additional water up to a point of application beyond which it increases at a decreasing rate. The relative position of this relationship depends upon the level of water management, so that curve A corresponds with a low level of management and curve B with a high level.

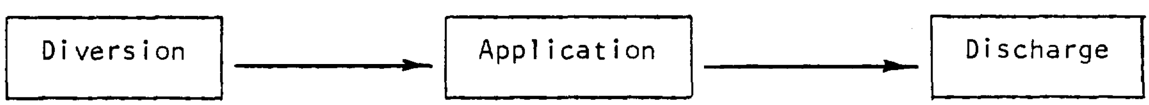


Figure 12. Phase of irrigation water use.

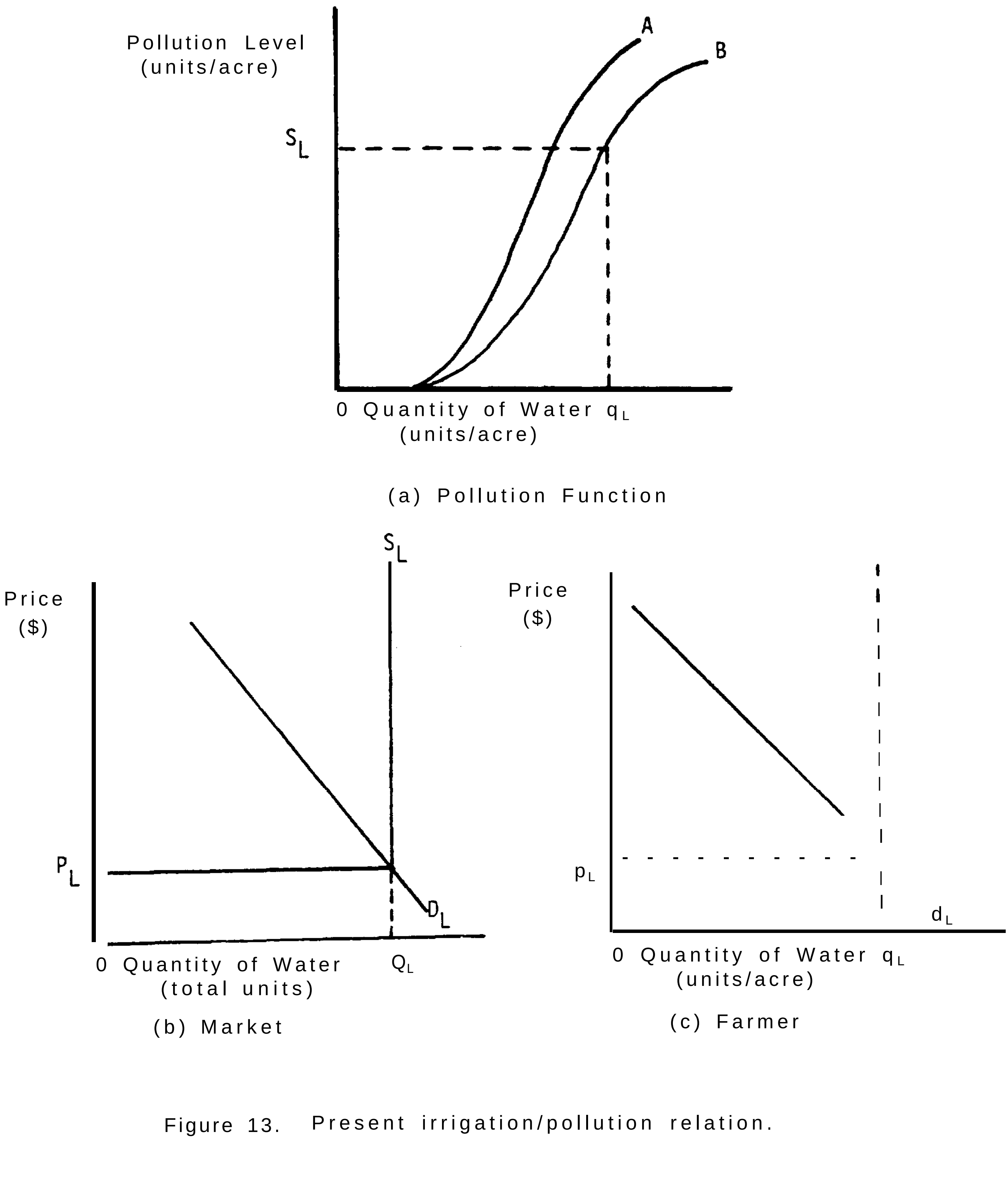


Figure 13. Present irrigation/pollution relation.

In the western United States, irrigation water is allocated by the Appropriation Doctrine or a modification of that doctrine. Under this doctrine, rights are determined on a "first in time, first in right" basis. The basis for establishing a right is the beneficial use of unappropriated water, While in theory the Appropriation Doctrine allows for both the transfer of water rights as well as simply the transfer of the water alone, a number of impediments exist which effectively preclude such transfer in most areas. In some states, irrigation water is tied to the land. Also, in order to develop many irrigable areas, states have often allowed the United States Bureau of Reclamation to appropriate large portions of the available water supply for irrigation projects. The terms of contracts in these projects may prohibit water transfers in order to insure repayment of construction costs. Finally, water transfers are impeded by the hydrologic uncertainties of most systems. That is, the physical interrelationships of water users may not be well defined so that effects of third party transfers are subject to varying legal rulings.

Since the appropriation cost of irrigation water is zero and the conveyance cost per unit of water is generally constant, the aggregate supply curve, S_L, under the present institutional arrangement is a horizontal line at the level of the conveyance cost, P_L, out to the total quantity of water available for use, Q_L. At Q_L, the supply curve becomes vertical (Figure 13(b)).

Summation of the demand of all water right holders at any point in time yields the equivalent of a market demand curve. As the demand for water in a given river basin increases, the market demand curve shifts outward until D_L is reached (Figure 13(b)). At that level of demand, the river's waters are completely allocated and no further water rights are issued.

With a normal downward sloping demand curve, d_L in Figure 13(c), the individual farmer will rationally demand Q_L units of water per acre at the average conveyance cost of P_L per unit of water. He will apply for and receive a right for that quantity as long as water is available. The actual allocation will depend on additional physical and legal considerations but the tendency will be towards an allocation of Q_L units per acre of irrigation water. If the level of water management corresponds with curve B in Figure 13.a, then the present allocation system results in an irrigation return flow pollution level of S_L units per acre.

Adjustments to the problem of irrigation return flow quality can be categorized according to their incidence on the three phases of irrigation water use shown in Figure 12. In general, these adjustments deal with the application and discharge phases of irrigation water use. The permit system is directed towards the third phase of irrigation water use. That is, it attempts to regulate the quality of water discharged from irrigated farms. Irrigation return flows, however, are diffuse and not easily identified with their source. Both surface and subsurface return flows freely mingle from a multiple of sources so that measurements and identification of pollution sources are extremely difficult, if not impossible. Furthermore, the permit system does not seek to reduce pollution to its optimum level, but rather to license an arbitrary level of pollution discharge. Indirectly, this mechanism may affect the relative price of water and, thus, the profit maximizing mix of inputs, but no necessary relation exists between monitoring discharges and the efficient allocation of agricultural resources.

More recently, attention has focused on the application phase of irrigation water use. Here, the mechanism of adjustment has been to improve on-farm management of water. In general, this entails the addition of capital and labor inputs to improve the efficiency of water use and reduce water pollution resulting from poor farming practices. This approach is often expensive and involves detailed studies and direct government intervention to implement. The major problem with this mode of adjustment is that unless the farmer is not currently maximizing profits, then reducing pollution by changing the mix of inputs will require subsidization of the farmer. This adjustment generally implies reducing the farmer's cost of labor and/or capital investment through a subsidy. Moreover, this approach involves extensive and, generally, expensive investigation to determine the appropriate new mix of inputs.

Finally, this discussion leads to the consideration of methods for reducing return flow pollution through adjustments in the first or diversion phase of irrigation water use. If excessive amounts of water are being combined with other inputs, then the indication is that this resource is underpriced. That is, if return flow pollution results from an improper mix of inputs, then the cause may be that the price of water (P_W) is too low.

Suppose a water rental market is created such that nonwater right holders could rent water from those with water rights without jeopardizing those rights. Water right holders acting as suppliers of rental water would have an upward sloping supply curve, S_R, representing increasing opportunity costs as shown in Figure 14.b. This supply curve represents the quantity of water that water right holders would rent rather than use at each price. The rental market demand curve, D_R, represents the aggregate marginal value product of irrigation water to nonright holders. The equilibrium quantity, Q_R, represents the amount of water right holders would rent to nonright holders,

Individual water right holders would adjust to the rental market equilibrium price, P_R, by reducing the quantity of water irrigated from q_L to q_R. That is, water right holders could realize a greater return from their right to q_L units per acre and renting the surplus (q_L - q_R) units per acre. The derived demand for irrigation water with a rental market, d_R, differs from the present demand curve, d_L, in that it is horizontal at the market price level beyond q_R, as shown in Figure 14.c.

If nonright holders are assumed to have identical irrigation demand curves to those with water rights, d_L, then each nonright holder will also rationally use q_R units of water per acre at a rental market equilibrium price of P_R. The effect on irrigation return flow pollution is that each farmer would cause S_R rather than S_L units of pollution per acre, as shown in Figure 14.a. On the other hand, there are more irrigators. The net effect of the rental market depends upon the ratio of the proportional increase in the number of irrigators to the proportional decrease in the

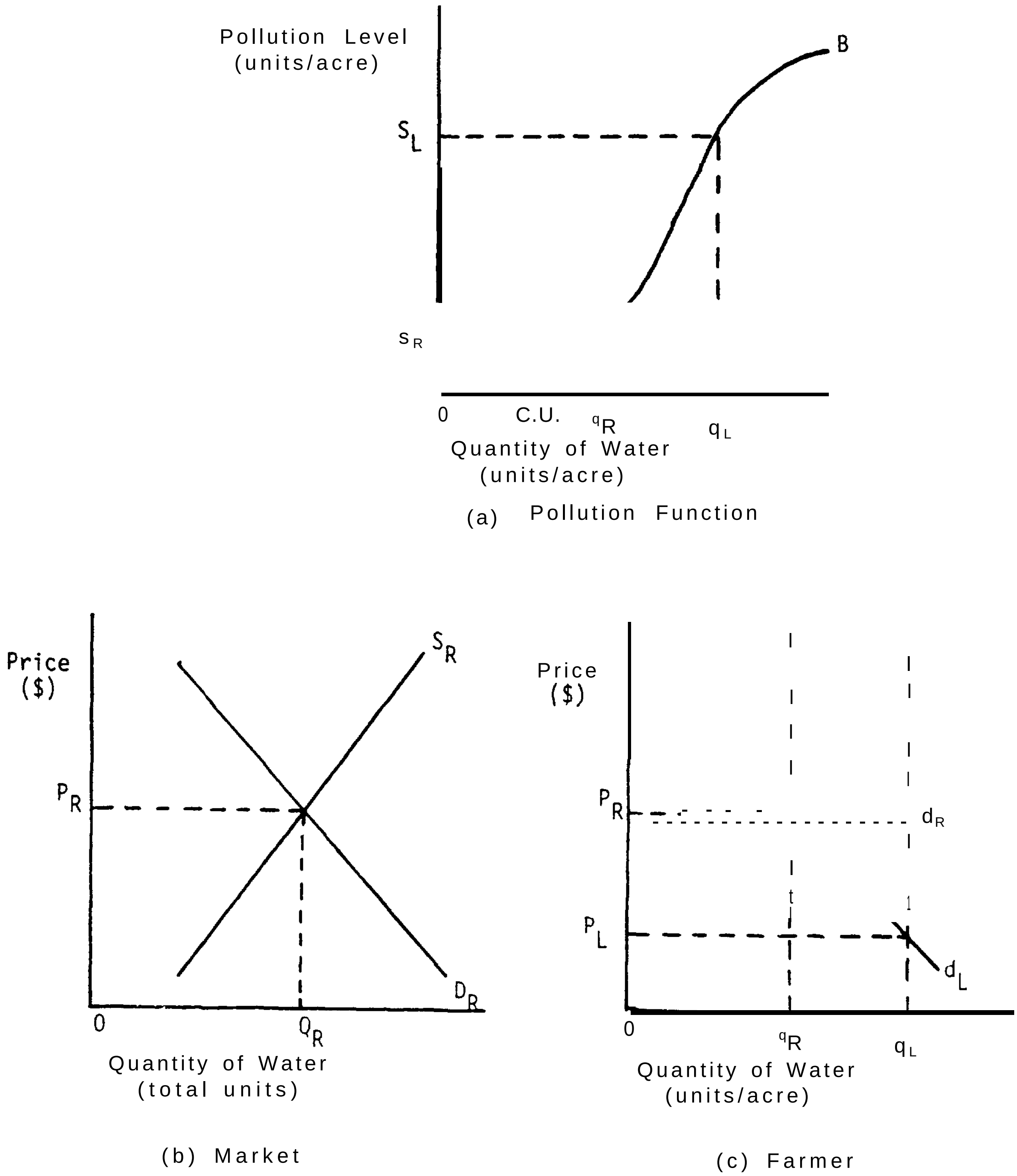


Figure 14. Irrigation/pollution relation with rental market.

pollution of each irrigator. If the ratio is less than one, then total pollution would decline.

Finally, if water quality is considered, the supply function may be more steeply sloped. Society as a whole has an interest in how water is used, so that an additional cost is associated with the use of water for irrigation--a pollution cost to society. The sum of the private and social marginal costs of irrigation water results in a rental market supply schedule above the supply curve ^{S}R. The optimum application of irrigation water per acre by an individual farmer would thus be reduced, which in turn would reduce the per acre pollution level.

The point is that a freely operating market for water would reallocate water automatically and without outside interference. The consequence would be a reduction in the level of return flow pollution both as a function of the reduced level of diverted water and improved management. That is, establishing a market for water would reallocate the quantity of water used for irrigation, thus reducing the return flow pollution level. This may also shift pollution curve A downward, thus reducing pollution below ^{S}R.

The private market solution may, however, not achieve a social optimum. Return flow pollution represents an external diseconomy to society as the actual cost of use is greater than simply the private cost. Given the private market adjustments, additional pollution reducing activities may still be warranted. Here at the margin, then, is the proper place for extra-market adjustments such as tax subsidy schemes, legal measures and engineering works of the government.

A market allocation might not be sufficient to correct all return flow pollution. Farmers would still have a profit motive for externalizing all possible production costs, including the costs of controlling pollution. Water users (or irrigation districts and companies) should be required to internalize costs imposed on other water users, public or private, through adoption of standards and criteria for beneficial use and creation of programs (voluntary incentives) and penal ties (compulsory compliance) that enable water administrators or adversely affected parties to employ. In economic terms, this means the imposition of taxes and subsidies. The particular form and application of such taxes and subsidies can only be specified for particular cases. In general, taxes can be utilized to adjust the price of water to approximate a market price, thus inducing farmers to be more efficient in its use. Taxes can also be used to penalize farmers for return flow pollution, but monitoring costs are typically prohibitive. Subsidies in the form of direct payments or technical assistance and capital improvements appear most applicable for improving on-farm management water. Taxes and subsidies may be jointly applied, for example, with a tax on water to approximate its market value and the revenues from this tax being used to subsidize farmers to adopt less polluting methods and techniques of water use.

The argument made above concerning legal considerations involved in problems of water quality has set the stage for potential solutions improving the law's sensitivity and ability to address such problems. Essentially, identifiable solutions include: adoption and enforcement of criteria for beneficial use, waste and water duty; removal of constraints concerning transfer of excess or saved waters within irrigation districts, promotion of low-cost funding; internalization of costs through adoption of standards for water use, creation of programs, or compulsory compliance, all of which would enable employment by water administrators or adversely affected parties.

Finally, the various alternatives must take into consideration both individual attitudes and the organizational structure that provides the rules and mechanisms which influence individual behavior. For the individual, potential solutions must involve an awareness of the critical character of irrigation return flow. On the other hand, for the organizational context, solutions revolve around the creation of mechanisms and practices which can facilitate the adoption of means for acceptable water quality standards.

Awareness by the farmer entails two conditions. First, the awareness should be towards specific on-farm management procedures which enhance water quality. In addition, a holistic approach as to why improved water quality will enhance not only his neighbor's operation, but also his own, must be explicated. Clean water should be seen as beneficial to the farmer and this benefit must be viewed as one that can be attained only through an areawide involvement of water users.

Instilling this individual behavior as a public good can only be accomplished when the organizational structure supporting the farmer embraces broader and firm commitment to cleaner water. This can be done by exploiting the existing structure; by changing or restructuring present arrangements; or by adding to the existing framework. The use of existing mechanisms such as the extension service, SCS, the local mass media, Co-ops, etc., can provide communication and information networks from which the individual farmer can become aware of the problem and the solution. Yet, some valleys do not have a well-organized system of communication by which water quality conditions are adequately processed, investigated and disseminated. Such an organization can be established either by modifying the existing structure or creating a new one altogether. This organization should work with farmers, agencies and the public in such a manner that it serves as a focal point for water quality information; and as a nodal point through which flow and exchange of information can be transferred into coherent, collectively arrived at policies.

It should be noted that in the juxtaposition of individual and organizational approaches, the assumption was made that acceptance of new management procedures will follow dissemination of knowledge and awareness. However, this is not always the case. Since there is not a necessary or sufficient causal relationship between "appropriate" and "acceptable" solutions, systems of rewards and penalties must also be established in order to provide support, to reinforce desired behavior, and generally, in order to make sure that proposed solutions will not die because of neglect or lack of sustained implementation by the users. Yet, as with all other solutions, these proposed monitoring and enforcement mechanisms must have an effective say or part in any decision-making process regarding return flow quality control. For, at the end, the pursuing of an effective water policy is part of a larger commitment and of an ethos that combines individual motivation and economic opportunities within an organizational context that makes possible collective social action and timely technical interventions.

As indicated earlier, the alternative solutions proposed for assessment and evaluation ranged from those which were wholly technical (e.g., rehabilitation of distribution systems) to those which were institutional. Some were combinations of technical and institutional measures which would cause improvements in quality of return flows (e.g., cost-sharing arrangement for improved irrigation facilities). They can be generally classed as: a) those directed to sources of water, generally, those which would increase supply; b) those concerned with the influent, i.e., the water diverted to agriculture; c) those associated with the management of land and water on farms; and d) those which were concerned with the effluent, i.e., the return flow.

We have now reached an important junction in our thinking. It was emphasized above that there seems to be a widespread agreement that as far as agricultural pollution is concerned, an NPDES approach seems to be a cumbersome, if not unrealistic, policy device. In this context, it is important to relate two different approaches that seem to emerge with regard to the problem of controlling return flow. One may be described as a generalized approach or effluent control approach whose characteristics are: a) a system of permits which everybody agrees may end up as an administrative nightmare; b) the coverage of a wide area or a system of at least statewide implementation; and c) emphasis on monitoring and on a corrective, if not punitive, approach.

On the other hand, another approach has already been described by Skogerboe and Radosevich (1977) as the Influent Control Approach, or the localized emphasis approach, whose characteristics are: a) the resolution of the problem at the source (preventive approach); b) emphasis on narrowly prescribed or designated areas; and c) voluntary compliance through incentives.

Each of these approaches has advantages and disadvantages. The effluent control approach has the potential advantage that it is administratively efficient, although it may have low effectiveness with reference to specific or localized areas. On the other hand, the influent approach, while it may be highly effective, probably has difficulties of administration (low efficiency). In either case, it is obvious that the general premises introduced by the NPDES system concerning agriculture have created major reaction and since limited agreement can be found particularly with regard to technical solutions, perhaps a mixed approach may be more appropriate. By using both local or limited areas and by working in a parallel fashion on general guidelines, it may be possible to build both cumulative findings as to questions of agricultural pollution and also exprience as to specific steps required for irrigation return flow quality control efforts.

COMBINATIONS OF SOLUTIONS

The previous discussion on solutions to problems of irrigation return flow quality points out that when all is said and done, the heart of the matter remains resistance by the public as a result of disagreement as to the existence or extent of the problem and as to perceived advantages from a variety of solutions. But, more important, "solutions" do not operate in neat categories, or hierarchical systems of categorical approaches. Technical, legal, economic, and social approaches are all intertwined with limitations, overlaps and trade-offs within and between categories.

There are innumerable possible combinations of solutions to the irrigation return flow problem. Most adjustments suggested here could not be implemented independently of other physical, economic, legal, or social concerns. Packages, or combinations of solutions, are difficult to construct since they tend not to be generalizable, but situation-specific. One cannot provide a complete listing of such combinations. Brief illustrations have been used in the case studies in order to show the types of mixes which would be likely and the realistic adjustments that must be made if implementation steps are to be followed.

It soon became obvious that no one alternative solution will suffice in the attempt to solve or at least materially alleviate the problem of degradation of quality of water used in irrigated agriculture. It also seems obvious that no solution or combination of solutions can be implemented which will entirely solve the problem of polluted return flows from agricultural lands. Some degradation of quality is inevitable if water is used for irrigation. There will be some increase in salinity, in sediment, and in other foreign materials simply because water has been combined with soils, fertilizers, seeds, and other inputs in agricultural enterprises. We must recognize this inevitable impact on water quality and find the acceptable "trade-offs" which will al low water to be used in agriculture.

The combinations of alternative solutions are finite, but very numerous. Development of the combinations always requires imagination, analysis, evaluation, and finally, decision about what is "best." Again, the case studies exemplify in some detail the effort to develop "packages" and the attempt to evaluate solutions and combinations of solutions appropriate to the particular regions.